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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

MANUFACTURING COST DETERMINATION

VOLUME 5

by

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PREFACE

This volume presents a preliminary survey of cost factors applicable to electronic equipment of stacked wafer modular desing as produced by mechanized or semi-mechanized techniques. Specifically, the volume is a reproduction of a report submitted to the National Bureau of Standards by Mead Carney and Co., Inc., management consultants. This manufacturing cost determination, although necessarily tentative, is based upon the best data on PROJECT TINKERTOY available at this time and is issued at the particular request of the Navy Bureau of Aeronautics, sponsors of the program.

Since the receipt of the Mead Carney Company's report, the Navy has announced that the name, PROJECT TINKERTOY, is no longer to be used to describe the program. Rather, modular design of electronics and mechanized production of electronics are to be used to designate the respective phases of the program. However, in order to make this volume immediately available to the electronics industry, it is being duplicated directly from the original manuscript. Consequently the name PROJECT TINKERTOY appears in some instances.

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INTRODUCTION

I - INTRODUCTION

Description of Project Tinkertoy

Project Tinkertoy is the code name of a new system for manufacturing electronic circuits, which is illustrated on Exhibit I opposite. It was conceived and developed by the National Bureau of Standards and sponsored by the U. S. Navy Bureau of Aeronautics.

The unique basic component of Project Tinkertoy is the ceramic wafer. It provides the base onto which the major portion of the circuitry is printed. This silver paint base circuit is affixed by heat, which is a principal reason for the use of ceramics. The wafer rigidly supports, and has attached to it, a variety of electronic elements, such as resistors, capacitors, potentiometers, tube sockets, and tubes.

Tiers of up to six such wafers, each appropriately printed and electronically equipped, are assembled together into rigid module structures by 12 vertical riser wires (3 per edge) which, at the same time, provide structural strength and appropriately connect the circuitry of adjacent wafers. These module assemblies constitute the intrinsic core of the Tinkertoy concept.

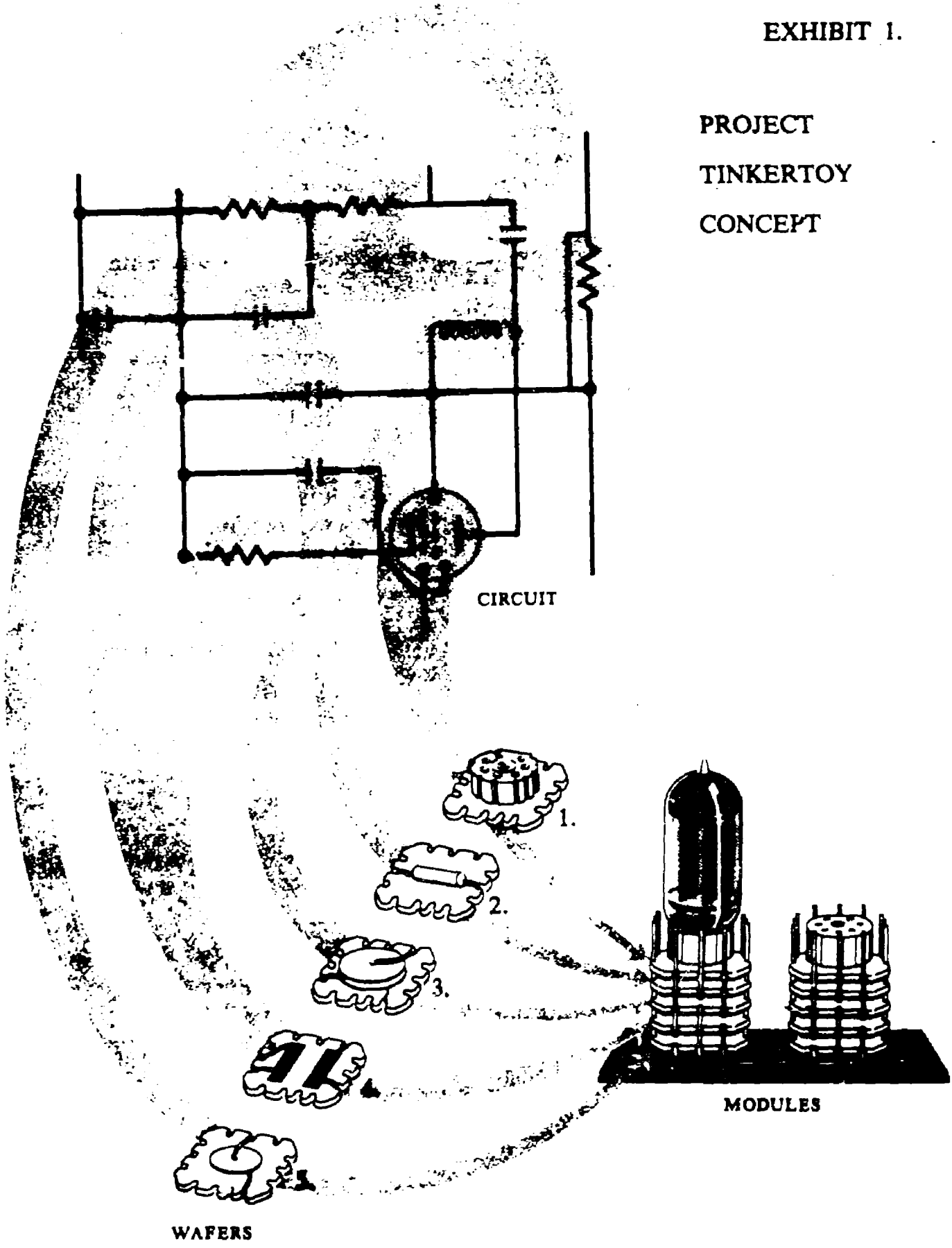
The Project Tinkertoy system of manufacture is applicable to hand or machine methods, and is particularly adaptable to automatic machine production.

EXHIBIT 1.

PROJECT

TINKERTOY

CONCEPT



Objectives

Electronic equipment manufactured thus far by Tinkertoy methods has been processed largely on a pilot plant and model shop basis; and not on a conventional industrial production basis.

It became necessary to determine costs of manufacturing for the Tinkertoy system for comparison purposes. Consequently, the objectives of this survey are to:

1. Determine the cost of manufacturing a specific item of electronic equipment by Tinkertoy hand and Tinkertoy machine processes, as adapted and projected to conventional production practices.
2. Compare these costs with the cost of manufacturing a similar item by conventional methods and practices.

Limitations

The scope of this survey does not include technical evaluation of Project Tinkertoy processes.

As indicated previously, Project Tinkertoy manufacturing observed during this survey was of a pilot plant and/or model shop nature. There was little production experience and data to draw on; particularly in the machine processing operations. Consequently, the cost figures for machine processing were necessarily based largely on estimates for net machine yields, and are subject to revision as operating experience is gained.

The cost figures for hand processing are based to a large extent on time studies of operations. They are, therefore, less subject to revision with the accumulation of production experience, except as necessitated by methods improvements.

Approach

The objectives outlined previously have been accomplished by:

1. Analyzing the Project Tinkertoy hand and machine processes to determine process flow, and to delineate the individual process steps. This information was needed to facilitate comparison of each step of the hand and machine processes.

2. Selecting an appropriate item of electronic equipment on which to base the cost comparison.

3. Establishing a basis for developing cost data for this item, which would have a wide application in both government and industry.

4. Evaluating the state of development of the present hand and machine operations on the basis of available historical data, observations, and the estimates of those most familiar with the processes and equipment. This evaluation established sound bases and assumptions for the determination of cost data for a projected commercial operation.

5. Developing costs for:
   a. hand and machine processes, step by step, and establishing breakeven points between the two processes.
   b. individual hand and machine manufactured modules required for the item selected for the cost comparison,
   c. the complete item of equipment selected as a vehicle for cost comparison as manufactured by the Project Tinkertoy hand and machine processes.

6. Obtaining costs for the selected item as manufactured by conventional methods, and comparing with the cost of manufacturing the item by Project Tinkertoy methods.

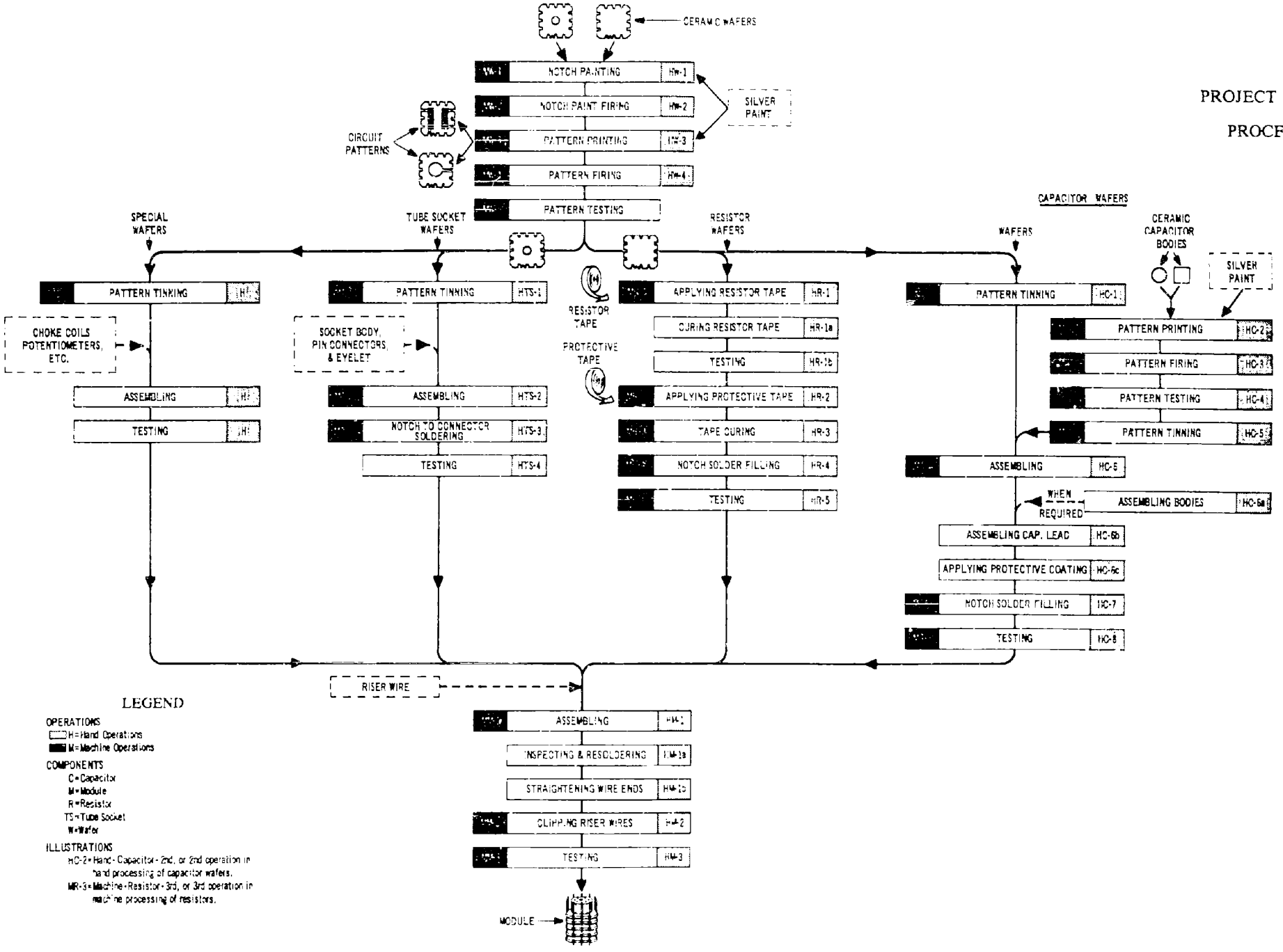
II

PROJECT TINKERTOY PROCESS FLOW

EXHIBIT 2.

PROJECT TINKERTOY

PROCESS FLOW



LEGEND

OPERATIONS
- H=Hand Operations
- M=Machine Operations

COMPONENTS
- C=Capacitor
- M=Module
- R=Resistor
- TS=Tube Socket
- W=Wafer

ILLUSTRATIONS
- HC-2=Hand-Capacitor-2nd, or 2nd operation in hand processing of capacitor wafers.
- MR-3=Machine-Resistor-3rd, or 3rd operation in machine processing of resistors.

III
SELECTION OF ITEM FOR COSTING PURPOSES

III–SELECTION OF ITEM FOR COSTING PURPOSES

Criteria:

The following criteria were considered in selecting an item of electronic equipment for use as a vehicle for the cost comparison:

1. The item must have been produced by both conventional and Tinkertoy methods.
2. It should consist largely of Tinkertoy system components, so as not to mask the economic effects of the application of Tinkertoy to manufacture.
3. Manufacturing costs must be obtainable for the conventionally produced version of the item.

Item Selected

The item selected on the basis of the foregoing criteria was an Intermediate-Frequency Amplifier. This unit, illustrated on Exhibit 3 opposite, is similar to interchangeable subassemblies which are incorporated into a variety of complete electronic assemblies. It will be referred to as an I F Amplifier throughout the report.

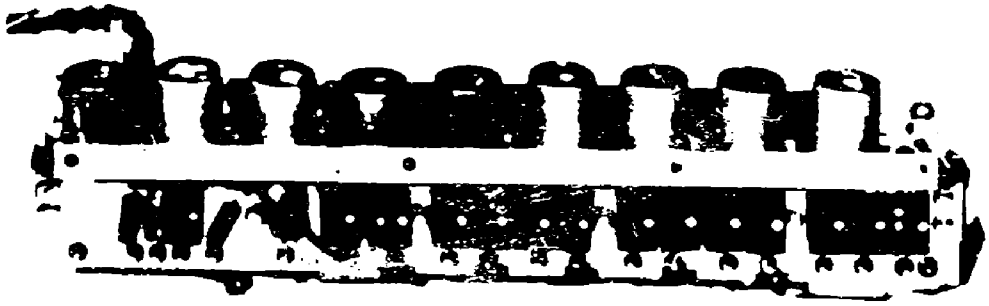
While the I F Amplifier satisfies the criteria referred to previously, its component modules have been produced by Tinkertoy processes only in a four-wafer design, and only by hand.

These particular four-wafer layouts were not adaptable to machine assembly. Five-wafer modules, adaptable to machine assembly, were therefore laid out for costing purposes. They were carefully checked for electrical correctness.

Though these module layouts have not been built, similar modules have been built and tested. It is considered, therefore, that no significant error will result from using these module layouts for cost comparison purposes.

INTERMEDIATE FREQUENCY (I F) AMPLIFIERS

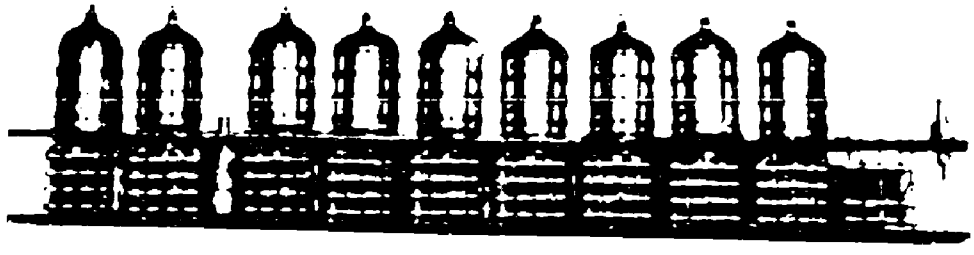
CONVENTIONAL UNIT



Side

Bottom

PROJECT TINKERTOY UNIT



IV
ESTABLISHMENT OF COSTING BASIS

IV—ESTABLISHMENT OF COSTING BASIS

Elements of Cost

The sales price of a product is normally composed of the following major cost elements, as illustrated on Exhibit 4, opposite.

1. Profit
2. Sales and Administrative Expense
3. Manufacturing Costs

Establishment of Costing Basis

It was decided to use the Manufacturing Cost element of the sales price of a product as the basis for determining and comparing costs for Project Tinkertoy, for the following reasons:

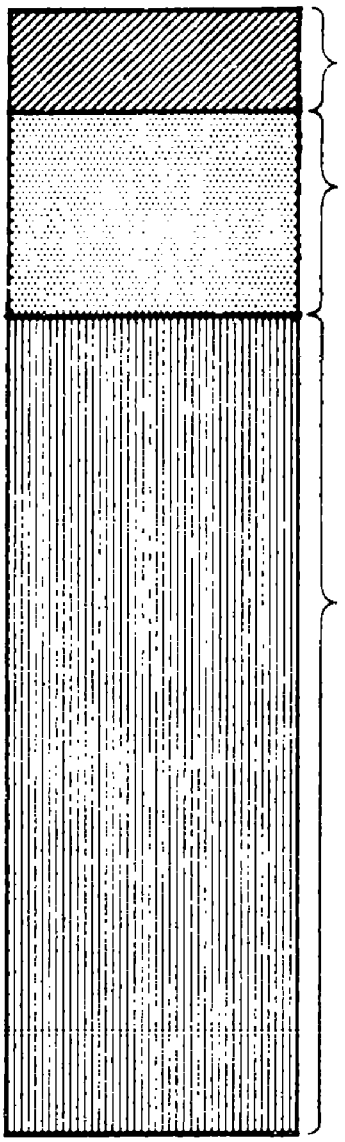
1. Manufacturing Cost covers the basic manufacturing and processing expense, and is the element of cost on which the other cost elements are based. It is not particularly affected by extraneous factors such as sales policies, market demand, etc.

2. Manufacturing Cost figures can be compared readily with similar cost figures throughout industry, and can be adjusted for more exact comparison, if desired, for any specific set of operating conditions.

EXHIBIT 4.

SALES PRICE OF A PRODUCT

SALES PRICE



1. PROFIT

2. SALES AND
   ADMINISTRATIVE EXPENSE

3. MANUFACTURING COSTS

   a. Materials

   b. Direct Labor

   c. Manufacturing Overhead

      (1) Indirect Labor

      (2) Machine, Equipment, and Tool Expenses

      (3) Occupancy Expense

      (4) Miscellaneous Expenses

STANDARD COSTING RATES

In determining the direct labor and manufacturing overhead costs, the representative rates and ratios shown on Exhibit 5 opposite were used.

The percentage of overhead expenses apportioned as fixed costs for use in determining breakeven points between hand and machine processes, are also shown on Exhibit 5.

PROJECT TINKERTOY

MANUFACTURING COST STANDARD RATES

ITEM	OPERATIONS Rate or Ratio Machine	Hand	Distribution % Fixed Cost
1. WAGE RATES			
a. Highly skilled	$2.40	$2.40	—
b. Skilled	2.00	2.00	—
c. Semi-skilled	1.60	1.60	—
d. Unskilled	1.20	1.20	—
2. FACTORY OVERHEAD			
a. Indirect Labor (% of direct labor cost)	30%	30%	30%
b. Machine, equipment, tool cost			
1. Annual Depreciation	10%	10%	100%
2. Interest charged on capital required	4%	4%	100%
3. Annual taxes & insurance	1%	1%	100%
4. Maintenance (% of equipment cost)	Avg. 20%	5-15%	25%
5. Utilities			
a. Electricity	.02/KW HR.	.02/KW HR.	—
c. Occupancy expense			
1. Ratio of Total Space to process space	6/1	5/1	—
2. Annual Rental / sq. ft.	$1.00	$.80	100%
3. Annual Heat / sq. ft.	.10	.10	75%
4. Annual Light / sq. ft.	.30	.30	10%

V
DETERMINATION OF MANUFACTURING COSTS

V–DETERMINATION OF MANUFACTURING COSTS

The projected Manufacturing Costs for Project Tinkertoy, consisting of the major cost elements–Material, Direct Labor, and Manufacturing Overhead–outlined in the previous section, were determined according to the following procedures:

Materials Costs

In order to develop manufacturing costs for the Tinkertoy I F Amplifier, it was necessary to establish proper costs for the materials used in its manufacture.

The development of costs for these materials was complicated by:

1. The relatively high cost of certain parts such as the ceramic wafers as now produced in small quantities at the pilot plant.
2. The necessarily small order quantities for some parts, resulting in comparatively high purchase prices for the items.
3. The fact that certain parts, such as base strips, have been handmade for this particular I F Amplifier, making it necessary to determine costs for such parts when manufactured in quantities.

All parts used in the Tinkertoy I F Amplifier are considered to be purchased parts, and the prices for these parts and materials as determined by appropriate appraisal, are shown in Exhibit 6, opposite.

MATERIAL COSTS
I F Amplifier.

Base strips	2 x $.700	—	$1.400
Brackets, tube shield	8 x .003	—	.024
*Cable, input coaxial	1 x 1.280	—	1.280
Capacitor bodies (regular)	32 x .014	—	.448
(small)	2 x .007	—	.014
Coil, tuning	1 x .950	—	.950
Coils, other	3 x .125	—	.375
*Cover assembly	1 x 2.170	—	2.170
Eyelets, tube socket	9 x .002	—	.018
Eyelets, other	150 x .005	—	.750
Plug, output	1 x .75	—	.750
Resistor strips	37 x .005	—	.185
Shield, inner stage	8 x .01	—	.080
Shield, input	1 x .02	—	.020
Shield, tube	9 x .0175	—	.158
Silver (at $1.27/troy ounce)			
Capacitor body painting	33 x .001	—	.033
Notch painting	49 x .001	—	.049
Tube socket patterns	9 x .0003	—	.003
Other patterns	66 x .0005	—	.033
Transformer, input	1 x .10	—	.100
*Tube, 6AC5	1 x .48	—	.480
*Tube, 6AK5	8 x 1.21	—	9.680
Tube Socket bodies	9 x .055	—	.495
Tube socket connector pins	63 x .005	—	.315
Wafer, ceramic	49 x .01	—	.490
Wire, riser	18.75' x .014	—	.263
			$20.563

*Same price as for conventional I F Amplifier

Direct Labor Costs—Tinkertoy Machine Process

To determine the operator or direct labor requirements for Tinkertoy machine processing, it was first necessary to determine machine and equipment requirements.

All of the Tinkertoy components manufactured to date by the machine process have been produced at a pilot plant established by the National Bureau of Standards, and now being operated by a commercial contractor.

Certain of the machines used have been adapted from standard machines with comparatively little modification. The majority, however, are relatively new designs, though they do contain some standard components.

Observations of the equipment during the survey indicated that the amount of machine delay, particularly from malfunctioning, was considerably higher than might be expected with comparable equipment in a more advanced state of development.

Some improvements have been developed, however, which have not yet been incorporated in the present equipment. Furthermore, experience indicates that development work on any piece of equipment can reduce malfunctioning delays to some extent. It was decided, therefore, that equipment and direct labor requirements based entirely on the current operations of the pilot plant would not provide a representative picture of the Project Tinkertoy machine process. Consequently, net machine production (or yield), and equipment requirements were based on the assumptions in the following section.

Assumptions for Projecting Equipment Yields. The projected machine process yields used in determining direct labor costs are based on:

1. Use of new equipment substantially like the present, operated at substantially the present cyclic rates, and incorporating improvements which have been developed during operations to date:

2. Machine delay time reflecting:
   a. The present stage of development of the equipment.
   b. General industrial practices and conditions with respect to time required for machine set-up, warm-up, clean-up, malfunctioning, maintenance, and operator's personal time.

3. Reasonable estimates of processed wafers or modules rendered unusable and therefore rejected due to equipment malfunctioning.

The projected yields are generally higher than current experience would indicate, but are considered to be reasonable expectations, based on the foregoing assumptions.

Equipment Requirements. As stated earlier, it was necessary to determine equipment requirements in order to establish operator, or direct labor requirements. The equipment requirements used in determining direct labor costs were based on:

1. Equipment yields based on the assumptions tabulated on the previous page.

2. The machine capacities necessary to process the required proportions of the various wafer components, such as resistors, capacitors, and tube sockets, comprising the ten modules for the I F Amplifier.

   Note: A check of another naval electronic device, produced by both Tinkertoy and conventional methods, indicated the possibility that the I F Amplifier wafer component ratio is representative of such devices. It should be stressed, however, that the production of other items might require larger percentages of tube sockets, resistors, and capacitors, and consequently, additional requirements for certain machines.

3. The necessity for a fairly balanced production line, in order to reduce to a minimum the economic loss resulting from unused machine capacity.

4. Operation of the facility on a 2-8-5, or two-shift, 8-hour shift, and five-day week b sis.

Production Line Balance and Facility Cost. The machine process yields developed from the foregoing are shown on Exhibit 7, together with the basic cyclic rates, machine delay times, and percentages of rejects on which these data are based.

After developing the equipment yields, the production line was balanced by adding to the present pilot plant operation the machines necessary to reduce to a minimum the total unused machine capacity consistent with a reasonable capital investment requirement. This resulted in a facility equipped to produce 405 five-wafer modules per hour, with an unused machine capacity equal to approximately 17% of the total investment. The number of pieces of equipment required for this facility are shown on Exhibit 7.

The replacement cost of the equipment required for this 405 module-per-hour facility is also shown on Exhibit 7. These costs were established by evaluation of purchase records and estimates of those most familiar with the development of the equipment.

Determining Direct Labor Costs. After establishing the equipment requirements, estimates were prepared of the number and skills of the operators needed, based on general industrial practice with similar equipments. These operator requirements are shown on Exhibit 7.

The number of operators, and the wage rates shown on the Standard Rate Sheet, Exhibit 5, were used to determine the machine process direct labor costs used in this survey.

PROJECT TINKERTOY MACHINE PROCESS – EQUIPMENT

1 Operation No.	2 Equipment Description	3 Basic cyclic rate (pcs./hr.)	4 Machine delay (hrs./8 hrs.)	5 % rejects	6 Net machine yield (pcs./hr.)	7 Factor for I F Amplifier
MW-1	Notch Painter	1,714	2.5	10%	1,060	4.9
MW-2	Notch Paint Filling	←				
MW-3	Pattern Printer	750	3.0	5%	445	4.9 ÷ 5
MW-4	Pattern Firing Furnace	2,143	3.0	–	1,339	4.7 ÷ 5
MW-5	Pattern Tester	3,000	1.5	10%	2,194	4.7
MR-1	Resistor Tape Applicator	1,500	2.0	5%	1,069	1.5
MR-2	Resistor Prot. Tape Applicator	1,500	2.0	5%	1,069	1.5
MR-3	Resistor Curing Oven	1,200	–	–	1,200	1.5
MR-4	Resistor Wafer Notch Tinner	579	1.75	10%	408	1.5
MR-5	Resistor Assembly Tester	632	1.5	5%	488	1.5
MC-1	Cap. Wafer Pattern Tinner	560	1.5	5%	432	3.2
MC-2	Cap. Body Pattern Printer	1,000	2.0	10%	675	3.2
MC-3	Cap. Body Pattern Oven	1,818	–	–	1,818	3.2
MC-4	Cap. Body Pattern Tester	2,143	1.5	5%	1,654	3.2
MC-5	Cap. Body Pattern Tinner	550	2.0	5%	392	3.2
MC-6	Cap. Assembler	359	2.5	5%	234	1.7
MC-7	Cap. Notch Tinner	579	1.75	10%	408	1.7
MC-8	Cap. Assembly Tester	632	1.5	5%	488	1.7
MTS-1	Tube Socket Pattern Tinning	←				
MTS-2	Tube Socket Assembler	240	2.5	5%	156	.9
MTS-3	Tube Socket Notch Tinner	579	1.75	10%	408	.9
MM-1	Module Assembler	125	2.0	10%	84	.9
MM-2	Module Riser Wire	270	2.0	5%	192	.9
MM-3	Module Tester	423	1.5	5%	327	.9

* HS – Highly Skilled
S – Skilled
SS – Semi-skilled
U – Unskilled

** Included in MW-1

*** Included in MW-3

AND DIRECT LABOR REQUIREMENTS

EXHIBIT 7.

8	9	10	11	12	13	14	15	16	17
1 F Modules per hr. (6 ÷ 7)	Machines required (405 mod./hr.)	Machine replacement cost Per Mach.	Total	Output items per hr.	required per hr.	Unused Capacity % (12 – 13) 12	Mach. Cost (11 x 14)	Operator Requirements Number & *Skills	Composite rate
216	2	$13,500	$27,000	2,120	1,985	6.4%	$1,722	2-S, 2-U	$6.40
OPERATION PERFORMED IN CAP. BODY PATTERN OVEN (SEE MC-3) →								**	–
473	1	26,500	26,500	445	381	14.3%	3,812	1-S, 1-SS & 1-U ***	4.80
1,424	1	9,000	9,000	1,339	381	71.5%	6,439		–
467	1	17,000	17,000	2,194	1,904	13.2%	2,240	1-H.S.	2.40
713	1	12,000	12,000	1,069	608	43.1%	5,175	1-SS	1.60
713	1	12,000	12,000	1,069	608	43.1%	5,175	1-SS	1.60
800	1	9,000	9,000	1,200	608	49.3%	4,440	†	–
271	2	5,750	11,500	816	608	25.5%	2,931	2-U	2.40
325	2	11,000	22,000	976	608	37.7%	8,295	2-HS	4.80
135	3	7,600	22,800	1,296	1,296	0 %	–	3-SS	4.80
211	2	10,000	20,000	1,350	1,296	4 %	800	2-SS	3.20
284	2	9,000	18,000	1,818	1,296	28.7%	5,168	‡	–
517	1	5,500	5,500	1,654	1,296	21.6%	1,190	1-HS	2.40
123	4	7,600	30,400	1,568	1,296	17.3%	5,273	4-SS	6.40
138	3	27,500	82,500	702	689	1.85%	1,528	6-SS	9.60
239	2	5,750	11,500	816	689	15.6%	1,790	2-U	2.40
287	2	12,000	24,000	976	689	29.4%	7,057	2-HS	4.80
OPERATION PERFORMED IN CAP. WAFER PATTERN TINNER (SEE MC-1) →									
173	3	32,000	96,000	468	365	22.0%	21,277	2-S, 2-SS	7.20
452	1	5,750	5,750	408	365	10.6%	606	1-U	1.20
93	5	31,500	157,500	420	365	13.1%	20,625	10-SS	16.00
213	2	14,500	29,000	384	365	4.9%	1,435	2-SS	3.20
363	2	8,000	16,000	654	365	44.2%	7,070	2-SS	4.80
			$664,950				$114,049		

† Included in MR-2

‡ Included in MC-2

Direct Labor Costs—Tinkertoy Hand Process

Most of the Tinkertoy components manufactured to date by the hand process have been produced in a model shop of the National Bureau of Standards. The major emphasis has been on development, rather than on production, and consequently the methods and worker pace are not equivalent to commercial practice. Direct labor requirements derived solely from current hand operations would not provide a sound basis for cost comparisons with conventional commercial manufacture.

Considering the present state of development of the Tinkertoy hand process, it was decided to time-study the individual manual process steps and to establish production rates per worker, based on general industrial conditions and practices with respect to worker pace, rest periods, personal time allowances, and delay factors.

The production rates per worker for the various hand process steps thus developed and shown on Exhibit 8 are considered to be applicable to the average industrial plant. While methods studies were not within the scope of this survey, specific methods improvements are reflected in several of the rates. It is apparent that production rates, in at least several process steps, may be further increased significantly by methods analysis and improvement.

In order to provide a direct comparison with the projected Tinkertoy machine processing operations, an equivalent Tinkertoy hand processing facility was projected with a capacity of 400 modules per hour. The equipment costs for this facility are also shown on Exhibit 8.

PROJECT TINKERTOY –
HAND PROCESS PRODUCTION AND EQUIPMENT DATA

Operation No.	OPERATION DESCRIPTION		Standard Dec. Hrs. Per Operation	Output in Pieces Per Hour	No Operators to Make 400 Mod. Hr	No. Work Stations Req.	Equipment Cost For Work Stations
HW-1	Wafer Notch Painting		.00880	114	17.248	17	$ 894.30
HW-2	Wafer Notch Paint Firing		.00044	2,273	.8624	(1)	224.40
HW-3	Wafer Pattern Printing	(1 side)	.00091	1,099	.5460	1	9,902.20
HW-3	Wafer Pattern Printing	(2 sides)	.00184	543	2.2080	2	–
HW-4	Wafer Pattern Firing		.00044	2,273	.8624	(1)	4,730.00
HC-1	Cap. Wafer Pattern Tinning		.00638	157	4.5936	5	937.75
HC-2	Cap. Body Pattern Printing		.00196	510	2.6656	3	7,422.80
HC-2a	Make Cap. Leads		.00055	1,820	.7480	1	100.10
HC-3	Cap. Body Pattern Firing		.00044	2,273	.5808	(1)	3,190.00
HC-4	Cap. Body Pattern Testing		.00176	568	2.3936	3	1,620.30
HC-5	Cap. Body Pattern Tinning		.00396	253	5.3856	5	937.75
HC-6	Cap. Body To Wafer Assembly	(.02+.01)	.01320	76	2.1120	2	1,008.70
HC-6	Cap. Body To Wafer Assembly	(Two .01)	.00715	140	2.2880	2	–
HC-6	Cap. Body To Wafer Assembly	(One .02)	.00473	211	1.3240	2	–
HC-6a	Assemble Cap. Leads	(1 side)	.00781	128	3.1244	3	474.93
HC-6a	Assemble Cap. Leads	(2 sides)	.01408	71	6.7584	7	–
HC-6b	Sub-Assemble Cap. Bodies		.00974	103	1.9480	2	378.40
HC-6c	Apply Prot. Coating	(1 side)	.00847	118	2.7104	3	334.40
HC-6c	Apply Prot. Coating	(2 sides)	.01694	59	6.7760	7	–
HC-7	Cap. Wafer Notch Solder Filling		.00880	114	6.3360	6	315.49
HC-8	Cap Wafer Assembly Inspections		.00286	350	3.8896	4	2,160.40
HR-1	Res. Tape Application	(1 side)	.00432	232	1.9008	2	135.30
HR-1	Res. Tape Application	(2 sides)	.00620	161	1.2400	1	–
HR-1a	Dry Res. Tape		.00044	2,273	.2816	(1)	1,540.00
HR-1b	Inspect		.00550	182	3.3000	4	596.20
HR-2	Prot. Tape Application	(1 side)	.00488	205	1.3664	2	246.40
HR-2	Prot. Tape Application	(2 sides)	.00783	128	2.5056	2	–
HR-3	Dry Prot. Tape		.00044	2,273	.2816	(1)	1,540.00
HR-4	Res. Wafer Notch Solder Filling		.00792	126	4.7520	5	937.75
HR-5	Res. Testing		.00550	182	3.3000	4	477.40
HTS-1	Tube Socket Pattern Tinning		.00589	167	2.1204	2	375.10
HTS-2	T. S. Parts to Wafer Assembly		.01276	79	4.5936	5	1,353.00
HTS-3	T. S. Wafer Notch Solder Filling		.01716	58	6.1776	6	1,395.90
HTS-4	T. S. Inspection		.00524	191	1.8864	2	358.05
HM-1	Module Assembly		.04235	24	16.9400	17	17,576.90
HM-1a	Inspect & Resolder		.01749	57	6.9960	7	373.42
HM-1b	Straighten Wire Ends		.00880	114	3.5200	4	200.20
HM-2	Riser Wire Clipping		.01716	58	6.8640	7	508.20
HM-3	Module Testing		.00275	364	1.1000	2	18,123.00
	Special Items		.05500	18	2.2000	4	201.65
	Final Assembly		.38500	2.6	15.4000	16	1,249.60
	TOTAL				182.0868	167	$81,818.99

Manufacturing Overhead Costs

The manufacturing overhead costs for the various cost comparisons developed in this survey were determined in the following manner:

Indirect Labor includes plant supervision, clerical, shipping and receiving, quality control, material handling, janitor and watchman service, etc.

The indirect labor expense was developed by estimating the wages and salaries of the personnel required to service commercial facilities similar to those projected for Tinkertoy hand and Tinkertoy machine processing. This expense, compared to the estimated total expense for direct labor, provided the 30% ratio shown on the Standard Rate Sheet, and used in distributing indirect labor costs to the various process steps for both hand and machine manufacture.

Machine, Equipment, & Tool Expense covers depreciation, interest charges for capital requirements, taxes and insurance, power consumption, and maintenance labor, materials, and overhead for all machines, equipment, and tools used.

This expense was developed by using standard rates, as shown on the Standard Rate Sheet, for depreciation, interest, and taxes and insurance and applying them to the estimated replacement costs of equipment required. To this was added the estimated maintenance and power expenses for the equipment, to obtain the total. The work sheet used to develop this expense is shown as Exhibit 9.

EXHIBIT 9.

PROJECT TINKERTOY - Machine, Equipment, & Tool Cost Data

Annual Equipment Costs Based on __ Shifts and ____ Hrs. Operations

		Total	Fixed	Variable
1.	Depreciation			
	Replacement Cost of Item _____	xx	xx	xx
	Annual Depreciation Rate 10%	xx	xx	xx
	Annual Depreciation _____	_____	100%	xx
2.	Interest charge for Capital required			
	Replacement Cost _____ x Rate % 4% =	_____	100%	xx
3.	Taxes & Insurance	xx	xx	xx
	Replacement Cost _____ 1% =	_____	100%	xx
4.	Maintenance _____	_____	25%	75%
5.	Utilities KW Hrs. _____ x Rate .02 =	_____	xx	100%
6.	Miscellaneous _____ _____	_____	_____	_____
	_____ _____	_____	_____	_____
	_____ _____	_____	_____	_____
	TOTAL COSTS	_____	_____	_____
		xx	xx	xx

Note: _____

Occupancy Expense was determined by estimating the space requirements of the facilities needed for the various operations, and multiplying the space by the average rates for rent, heat, and lights, shown on the Standard Rate Sheet. It will be noted that a lower rental rate was used for hand processing space than for machine processing space, based on the general practice of using more expensive space for automatic equipment installations.

Miscellaneous Expenses are numerous expenses incurred in connection with manufacturing facilities and operations, such as supplies, water and gas, employee benefits, loss and wastage, etc., for which it is difficult to establish general averages. However, it appeared reasonable to use a figure of 10% of the "Indirect Labor," "Machine, Equipment & Tool Expense," and "Occupancy Expense," to cover these miscellaneous expenses, and this 10% figure is used throughout this manufacturing cost determination.

Assembling Manufacturing Cost Data

The Manufacturing Cost Data for each step of the Project Tinkertoy machine and hand processes was developed as outlined in the preceding sections, and the data was assembled on work sheets illustrated on Exhibit 10, opposite.

The distribution between fixed and variable expenses was made according to the percentages shown on Exhibits 5 and 9.

EXHIBIT 10

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes _____ Mach. / Hand No. _____

Equipment _____ No. _____

Based on _____ shifts, _____ hrs., hourly prod. _____ and annual prod. _____

Item	Annual Cost Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. _____ x Rate _____ =		xx	
3. Manufacturing Overhead			
a. Indirect Labor = 30% of Direct _____ =			
b. Machine, Equipment & Tool _____			
c. Occupancy =			
Proc. Space _____ x Ratio = _____	xx	xx	xx
Rent _____ =			
Light _____ =			
Heat _____ =			
Subtotal - a, b, and c.			
d. Miscellaneous = 10% x Subtotal _____ =			
Total - a, b, c, and d.			
GRAND TOTALS			

Notes: _____

VI
PROJECT TINKERTOY
PROCESS STEP COMPARATIVE COSTS

VI–PROCESS STEP COMPARATIVE COSTS

Having developed complete manufacturing cost data, based on projected manufacturing facilities with capacities of 405 modules per hour for the Tinkertoy machine process and 400 modules an hour for the equivalent hand process, a comparison of the manufacturing costs for each step in the machine process was prepared.

These comparative process step costs per item processed are tabulated on Exhibit 11 opposite. The lower of the two costs is underlined to facilitate comparison at each step.

For each machine process step, a chart was also prepared depicting the variation between the manufacturing cost characteristics for the machine step and the comparable hand process step(s). These cost-volume charts involved utilization of the fixed cost overhead expense ratios referred to in Exhibit 5.

Wherever the cost characteristics for a machine process step and its equivalent hand process step(s) converged, and therefore, would intersect, a break-even volume was thereby determinable at which the manufacturing costs for both processes are identical. These break-even volumes were then determined by algebraic calculation, checked for correlation with the appropriate charts, and tabulated in Exhibit 11.

PROJECT TINKERTOY – PROCESS STEP COMPARATIVE COSTS

(Direct Labor and Manufacturing Overhead)

Oper. No.*	OPERATION DESCRIPTION	HAND		MACHINE		Break-even Volume**
		Unit Cost	Annual Volume**	Unit Cost	Annual Volume**	
Basic Wafer Preparation						
W-1, 2	Wafer Notch Painting & Firing	.0201	7,840	.00663	7,938	None
W-3, 4, 5	Wafer Pattern Printing, Firing, Testing	.00498	7,200	.00842	7,614	None
Resistor Wafer Preparation						
R-1	Resistor Tape Application	.0235	2,400	.00477	2,430	None
R-2	Protective Tape Application	.0141	2,400	.00477	2,430	67
R-3	Tape Curing	.00152	2,400	.00141	2,430	1,930
R-4	Wafer Notch Solder Filling	.0174	2,400	.00707	2,430	30
R-5	Inspection	.0121	2,400	.0124	2,430	2,915
Capacitor Wafer Preparation						
C-1	Wafer Pattern Tinning	.0140	2,880	.00504	3,390	140***
C-2, 3	Body Pattern Printing & Firing	.00717	5,440	.00612	5,184	2,179
C-4	Body Pattern Testing	.00392	5,440	.0028	5,184	219
C-5	Body Pattern Tinning	.00866	5,440	.00917	5,184	8,969
C-6	Body to Wafer Assembly	.082†	2,880	.0327	2,754	101†
C-7	Wafer Assem. Notch Solder Filling	.0192	2,880	.00674	2,754	None
C-8	Inspection	.0120	2,880	.0121	2,754	2,939
Tube Socket Wafer Preparation						
TS-1	Wafer Pattern Tinning	.0129	1,440	.00584	1,794	See C-1
TS-2	Parts to Wafer Assembly	.026	1,440	.0546	1,458	None
TS-3	Notch Solder Filling	.0375	1,440	.0063	1,458	None
Module Assembly						
M-1	Assembly	.0958	1,600	.1096	1,458	3,510
M-2	Riser Wire Clipping	.0375	1,600	.0212	1,458	204
M-3	Testing	.00928	1,600	.01325	1,458	None

*Preceded by "H" for hand processes, and "M" for machine processes.
**In thousands.
***For C-1 and TS-1 combined.
†For H-6, 6a, 6b, 6c combined.

VII
I F AMPLIFIER MODULE COMPARATIVE COSTS

VII – I F AMPLIFIER MODULE COMPARATIVE COSTS

The processing costs for the ten Tinkertoy I F Amplifier modules were determined according to the procedures previously outlined, and are shown in the following tabulation.

MODULE	Direct Labor		Manufacturing Overhead		TOTALS	
	Hand	Machine	Hand	Machine	Hand	Machine
M-1	.46514	.1483	.16823	.1392	.63337	.2875
M-2	.50031	.2209	.19535	.27464	.69566	.49544
M-3	.51031	.2209	.19815	.27464	.70846	.49554
M-4	.62458	.23886	.22821	.29286	.85279	.53172
M-5	.55956	.23977	.22746	.29850	.78702	.53827
M-6	.51961	.21342	.18702	.26786	.70663	.48128
M-7	.52111	.2209	.19435	.27464	.71546	.49554
M-8	.63576	.28313	.23481	.30701	.87057	.59014
M-9	.63468	.25118	.24730	.27139	.88198	.52257
M-10	.40372	.18195	.16065	.23558	.56437	.41750
	5.375	2.219	2.042	2.636	7.416	4.856

VIII
I F AMPLIFIER COMPARATIVE COSTS

VIII—I F AMPLIFIER COMPARATIVE COSTS

The manufacturing costs of the complete I F Amplifier were determined for both Tinkertoy hand and machine operations, based on the processing and materials costs previously shown, and on the final assembly costs detailed in an appendix to this report.

Manufacturing costs for the conventional I F Amplifier were obtained from a Navy contractor who had produced a considerable quantity of the item. These costs, together with similar costs for Project Tinkertoy hand and machine processing, are tabulated below.

METHOD	MATERIALS	DIRECT LABOR	MFG. O. H.	TOTALS
Conventional	$35.85	$5.60	$5.44	$46.89
Tinkertoy Hand	20.56	5.99	2.27	28.82
Tinkertoy Machine	20.56	2.83	2.86	26.25

IX
CONCLUSIONS

IX – CONCLUSIONS

The significant conclusions of this survey are as follows:

- Substantial reductions in electronic manufacturing costs appear to be possible through the use of either Project Tinkertoy machine or hand processes, as compared with conventional manufacturing methods. Based on the survey projections, the manufacturing cost reductions amount to 44% for the Tinkertoy machine process, and 38.5% for the Tinkertoy hand process.

- Manufacturing costs are lower for the Project Tinkertoy machine processing operations than for the hand processes in 13 of the 20 process steps, or groups of steps, delineated for this survey and indicate a 8.9% lower manufacturing cost for a complete I F Amplifier manufactured by Tinkertoy machine processes as compared to Tinkertoy hand processes.

- The substitution of lower-cost hand process steps, where appropriate, would result in a lower total manufacturing cost for the I F Amplifier than the present projected machine process total cost.

- The $665,000 investment required for the projected 405 module per hour machine process facility is approximately 8 times the $82,000 investment for the 400 module per hour hand process facility, but the difference in investment would be repaid from manufacturing cost savings within less than one year and five months of operations at full capacity.

- The Tinkertoy machine process uses fewer labor hours per unit produced than does the hand process, but requires a larger proportion of higher skilled personnel.

- Little, if any, manufacturing cost reduction would result solely from an increase in size of the projected Tinkertoy hand or machine process facilities. (Some reduction in material costs might be expected from larger purchase order quantities.)

- Significant reductions may be achieved in the present Tinkertoy hand process costs through methods improvements in several of the process steps.

- Significant reductions in the present Tinkertoy machine process costs would result from:

  Increases in equipment cyclic rates.

  Reductions in machine delay time.

  Reductions in percentages of rejects.

  Reductions in equipment costs.

  Reductions in numbers and skills of operators.

  Reductions in equipment maintenance costs.

APPENDIXES

PROJECT TINKERTOY

Manufacturing Cost Determination

Appendixes

A. Ceramic Wafer Manufacturing & Cost Data

B. Project Tinkertoy Processing Cost Data Sheets & Cost Volume Charts

C. IF Amplifier Module Cost Data

D. IF Amplifier Assembly & Test Cost Data

APPENDIX A

Ceramic Wafer Manufacturing & Cost Data

CERAMIC WAFER COST DETERMINATION

Objective determination of the manufacturing cost for the ceramic module wafer was complicated by the fact that the present facility is largely developmental in nature, and that some of the equipment is used for both module wafers and experimental capacitor wafers. In addition, the facility had been transferred from operation by the National Bureau of Standards to operation by a private contractor but two weeks before the start of the cost determination study.

Wherever possible, production capacities were determined by actual count or time study, as in the cases of wafer pressing, firing and gaging. In the remaining cases, the necessary data was obtained through the medium of statistical sampling and the analysis of available production statistics.

The wafer manufacturing process sequence is shown on Schedule A-2. It was found that, with the present module firing kiln and drying oven fully loaded on a 24-hour basis, the remainder of the processing equipment was very much under-utilized. It was considered appropriate, therefore, in order to achieve better utilization of this equipment for costing purposes and to approximate therefor a more normal manufacturing facility, to quadruple the kiln and oven capacities. This resulted in a costing basis of 52,000 wafers per 24-hour day, based on a maximum practical capacity of 13,000 wafers per 24-hour day for each furnace at 85% of optimum kiln capacity.

With the quadrupled kiln capacity, the kilns would continue to be the limiting factor in determining production capacity. Since the kilns are essentially intended to run on a continuous (24-hour a day) basis, except for necessary time out for repairs, this provided the basis for determination of yearly production capacity.

Appraisal of maintenance requirements for the wafer processing equipment, through consultation with pertinent operating personnel, revealed the need for shutting down each kiln one day per week, on the average, for maintenance and repairs and two weeks per year for rebuilding of refractory linings. Hence, with four kilns producing 52,000 wafers per day, the maximum practical capacity of the costing basis production facility became 15,600,000 wafers per 300-day year.

Ceramic Wafer Cost Determination (cont'd)

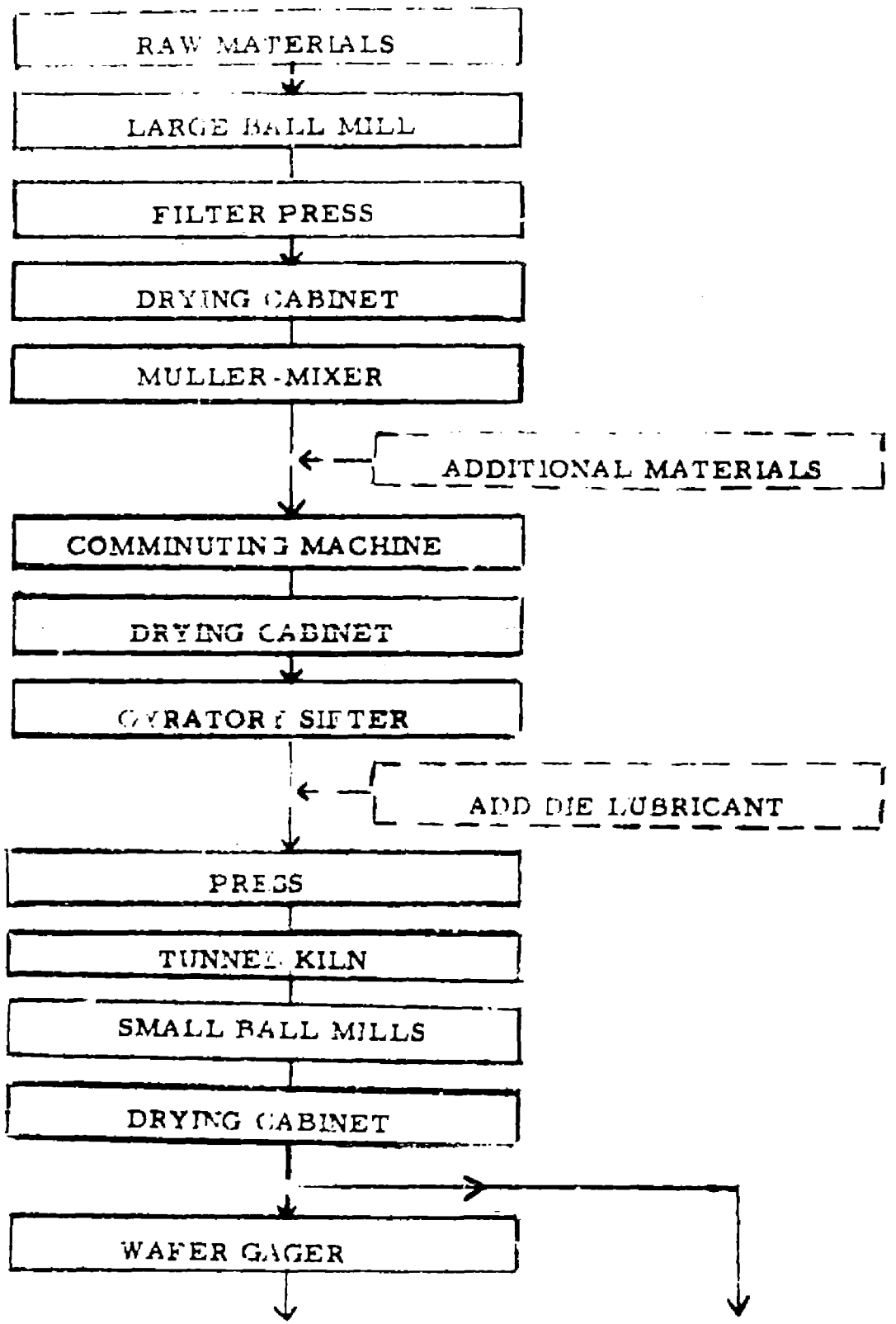
Analysis of some eight production batches completed during the period of the study indicated that an average yield of approximately 28,500 wafers per batch could be conservatively expected in normal production. This provided the basis for costing in the materials at the appraised cost of $16.50 per batch.

The analysis also indicated that, in the case of wafers intended for use in machine wafer and module fabrication, approximately 20% of kiln production would be rejected at the wafer gager as not being acceptable therefor. These rejects could, however, be credited as being usable for hand module fabrication wherein a lower degree of dimensional precision in the wafer is acceptable.

These, then, were the bases upon which the module wafer cost determinations were predicated. Detailed costing data is tabulated on Schedule A-3 of this appendix. Schedules A-4 and A-5 contain the cost determination of the wafer for use in hand fabrication. Determination of the cost of the wafer for machine fabrication purposes is presented on Schedules A-6 and A-7.

PROJECT TINKERTOY

Wafer Manufacturing Process Flow



PROJECT IDAHO/TOY

Appendix A, Schedule A-3

CERAMIC MODULE WAFER MANUFACTURING EQUIPMENT AND COST DATA SHEET

(Based on plant producing 24 hours per day, 300 days per year)

With production rates of: (a) Wafers acceptable for Hand Fabrication - 52,000 per day = 15,600,000 per year

(With 20% rejected at Gager) (b) Wafers acceptable for Machine Fabrication-41,600 per day= 12,480,000 per year

Nos. of Equipt. Reqd.	Column A Type of Equipment	Column B Estimated Replacement Cost $	Column C Hours used per 24 hr. day	Column D KWH. Power Reqd. per 24 hr. day	Column E Space Occupied Sq. Feet	Column F Maintenance $ Costs per year Labor	 Supplies	Column G Direct Labor Costs Per Day $		Column H Direct Labor Personnel Per Day
1	Large Ball Mill	1,627	22	44	48	116	100			
1	Filter Press	800	16	3	32	76	440			
4	Drying Cabinets	6,440	4 x 24	600	112	152	120			
1	Muller Mixer	3,830	20	24	25	76	60		153.60	Four semi-skilled men per shift
1	Comminuting Machine	1,837	8	30	30	76	60			
1	Gyrator Sifter	1,613	8	6	48	116	100			
1	Granular Blender	760	8	2	12	76	60			
2	Dual Pressure Presses	6,960	run 23 set-up 10	24	72	880dies	8,480			(Two semi-skilled men on 1st and 2nd
4	Tunnel Kilns	31,600	4 x 24	3,812	1,040	5,376	18,816	run	64.00	(shifts, one on 3rd shift
1	Small Ball Mill	983	18	8	14	38	100	setup	48.00	(One skilled leading man (per shift
	Misc. Auxiliary Equipment	1,569	As reqd.		629	76	60			
	Hand Fabrication Totals:	$58,019		4,553	2,062	7,058	28,396		265.60	
1	Wafer Gager	3,500	23	9	36	1,444	2,000		28.80	
	Machine Fabrication Totals:	$61,519		4,562	2,098	8,502	30,396		294.40	
					plus 30% O.H.	2,550				
						11,052	11,052			
							41,448			

HAND PROCESS WAFER

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Module Wafer Manufacture Hand No. _____

Equipment See Schedule A-3, Column A

Based on 3 shifts, 7200 hrs., 24 hourly prod. 52,000 and / 300 day annual prod. 15,600,000

Item	Total Annual Costs
1. Material - $16.50 per batch x 15,600,000 / 28,500 per batch	$ 9,031.61
2. Direct Labor - See Schedule A-3, Col. G	79,680.00
3. Manufacturing Overhead	
a. Ind. Lab. = 30% of Dir. $79,680 =	23,904.00
b. Mach., Equip. & Tool (See Schedule A-5)	73,592.25
c. Occupancy = (Per Schedule A-3, Col. E) Proc. Space 2062 x Ratio 6 = 12,372 sq. ft. @ $1.40 sq. ft.	17,320.80
Subtotal - a, b, and c	$114,817.05
d. Miscellaneous = 10% x Subtotal 114,817.05 =	11,481.70
Total - a, b, c, and d	126,298.75
GRAND TOTALS - Items 1, 2 & 3	$215,010.36

Notes:

Manufacturing cost per Module Wafer for Hand Fabrication = $\frac{\$215,010.36}{15,600,000}$

= 1.378 cents

Add Sales and Administration Costs (15%) and Profit (10%) Totalling 25% of Selling Price = 0.460

Purchase Price = 1.838 cents

HAND PROCESS WAFER

PROJECT TINKERTOY -- Machine, Equipment & Tool Cost Data

Annual Equipment Costs Based on 3 shifts and 7200 hrs.

	Total
1. Depreciation	
Replacement Cost of Item $58,019.00 (Per Schedule A-3, Col. B)	
Annual Depreciation Rate 10%	
Annual Depreciation $5,801.90	$ 5,801.90
2. Interest Charge for Capital Required	
Replacement Cost $58,019.00 x Rate 4% = (Per Schedule A-3, Col. B)	2,320.76
3. Taxes & Insurance 1%	580.19
4. Maintenance (Per Schedule A-3, Col. F)	37,571.40
5. Utilities - KW Hrs. 4553 x 300 x Rate .02 (Per Schedule A-3, Col. D)	27,318.00
Total Costs	$73,592.25

MACHINE PROCESS WAFER

PROJECT TINKERTOY -- Total Manufacturing Cost Data

Process Module Wafer Manufacture Mach.

Equipment See Schedule A-3, Column A

52,000 x .8 = 300 day 15,000,000 x .8 =

Based on 3 shifts, 7200 hrs., 24 hourly prod./41,600 and/annual prod./12,480,000

Item	Total Annual Costs
1. Material - $16.50 per batch x 15,600,000 / 28,500 per batch	$ 9,031.61
2. Direct Labor - See Schedule A-3, Col. G	88,320.00
3. Manufacturing Overhead	
a. Ind. Lab. = 30% of Dir. $88,320 =	26,496.00
b. Mach., Equip. & Tool - See Schedule A-7	78,048.45
c. Occupancy = Proc. Space 2098 x Ratio 6 = 12,588 sq. ft. @ 1.40 sq. ft. = (Per Schedule A-3, Col. E)	17,623.20
Subtotal - a, b, and c	122,167.65
d. Miscellaneous = Subtotal x 10%	12,216.76
Total - 1, 2, 3	231,736.02
Less credit for 3,120,000 rejected wafers salable for hand module fabrication @ 1.838¢ per wafer.	57,345.60
GRAND TOTAL	$174,390.42

Notes: Price per Module Wafer for Machine Fabrication =

$$\frac{\$174,390.42}{12,480,000} = 1.397 \text{ cents}$$

Add Sales and Administration Costs (15%) and Profit (10%) Totalling 25% of Selling Price = 0.466

1.863 cents

MACHINE PROCESS WAFER

PROJECT TINKERTOY -- Machine, Equipment & Tool Cost Data

Annual Equipment Costs Based on 3 shifts and 7200 hrs.

		Total
1	Depreciation	
	Replacement Cost of Item $61,519 (Per Schedule A-3, Col. B)	
	Annual Depreciation Rate 10%	
	Annual Depreciation $6,151.90	$6,151.90
2.	Interest Charge for Capital Required	
	Replacement Cost $61,519 x Rate 4% = (Per Schedule A-3, Col. B)	2,460.76
3.	Taxes and Insurance 1%	615.19
4.	Maintenance (Per Schedule A-3, Col. F)	41,448.60
5.	Utilities - KW Hrs. 4562 x 300 x Rate .02 =	
	Total Utilities	27,372.00
	Total Costs	$78,048.45

APPENDIX B

Project Tinkertoy Processing Cost Data

Schedules	Description
Basic Wafer Preparation	
B-1	(W1 & 2) Wafer Notch Painting & Firing
B-2	(W3, 4, & 5) Wafer Pattern Printing, Firing & Testing
Resistor Wafer Preparation	
B-3	(R-1) Resistor Tape Application
B-4	(R-2) Resistor Protective Tape Application
B-5	(R-3) Resistor & Protective Tape Curing
B-6	(R-4) Resistor Wafer Notch Solder Filling
B-7	(R-5) Resistor Inspection
Capacitor Wafer Preparation	
B-8	(C-1) Capacitor Wafer Pattern Tinning
B-9	(C-2 & 3) Capacitor Body Pattern Printing & Firing
B-10	(C-4) Capacitor Body Pattern Testing
B-11	(C-5) Capacitor Body Pattern Tinning
B-12	(C-6) Capacitor Body to Wafer Assembly
B-13	(C-7) Capacitor Wafer Notch Solder Filling
B-14	(C-8) Capacitor Inspection
Tube Socket Wafer Preparation	
B-15	(TS-1) TS Wafer Pattern Tinning
B-16	(TS-2) TS Parts to Wafer Assembly
B-17	(TS-3) TS Wafer Notch Solder Filling
B-18	(TS-4) TS Inspection
Module Assembly	
B-19	(M-1) Module Assembly
B-20	(M-2) Module Riser Wire Clipping
B-21	(M-3) Module Testing
Total Cost	
B-22	Total Projected Manufacturing Costs for Project Tinkertoy Hand and Machine Processes

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Wafer Notch Painting & Firing Mach. No. MW-1 & 2

Equipment See MW-1 & 2 Data Sheets

Based on 2 shifts, 3,744 hrs., hourly prod. 2,120 and annual prod. 7,938,000

	Annual Cost		
	Total	Fixed	Variable
MW-1 =	$47,394	$ 9,507	$37,887
MW-2 =	5,224	2,724	2,500
Totals --	$52,618	$ 12,231	$40,387

Notes:

Cost per piece for MW-1 & 2 =

$$\frac{\$52,618}{7,938,000} = .00663$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Notch Painting Mach. No. MW-1

Equipment 2-Notch Painters (A)

Based on 2 shifts, 3744 hrs., hourly prod. 2120 and annual prod. 7,938,000 wafers

	Annual Cost		
	Total	Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 4,000 x Rate 6.40 (B) =	$25,600	xx	$25,600
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 25,600 =	7,680	$2,304	5,376
b. Mach., Equip. & Tool	11,344	5,716	5,628
c. Occupancy = Proc. Space 94 x Ratio 6 = 564 sq. ft.			
Rent 1.00 x 564 =	564	564	---
Light .30 x 564 =	169	17	152
Heat .10 x 564 =	56	48	14
Subtotal - a, b, and c	$19,813	$8,643	$11,170
d. Miscellaneous = 10% x Subtotal 19,813 =	1,981	864	1,117
Total - a, b, c, and d			
GRAND TOTALS	$47,394	$9,507	$37,887

Notes:

(A) 2-Notch Painters @ $13,500 = $27,000
(B) 2 Skilled @ $2.00 = $4.00
2 Unskilled @ $1.20 = 2.40
$6.40

Cost per piece for MW-1 = $\frac{\$47,394}{7,938,000} = .0059$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Notch Paint Firing Mach. No. MW-2

Equipment 1-Furnace (A)

Based on 2 shifts, 3744 hrs., hourly prod. 2,120 and annual prod. 7,938,000 wafers

Item	Total	Annual Costs Fixed	Variable
1. Material	.	xx	
2. Direct Labor = Hrs. (B) x Rate		xx	
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir.			
b. Mach., Equip. & Tool	$3,674	$1,628	$2,046
c. Occupancy = Proc. Space 128 x Ratio 6 = 768 sq.ft.			
Rent 768 x 1.00 =	768	768	
Light 768 x .30 =	230	23	207
Heat 768 x .10 =	77	57	20
Subtotal - a, b, and c	$4,749	$2,476	$2,273
d. Miscellaneous = 10% x Subtotal = 4,749	475	248	227
Total - a, b, c, and d	5,224	2,724	2,500
GRAND TOTALS	$5,224	$2,724	$2,500

Notes:

(A) 1-Furnace @ $9,000

(B) Direct Labor Included in MW-1

MC-3 Operation includes balance of cost

Cost per piece = $\frac{\$5,224}{7,938,000}$ = .00066

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Notch Painting & Firing Hand No. HW-1 & 2

Based on 2 shifts, 4000 hrs., hourly prod. 1960 and annual prod. 7,840,000

	Annual Cost		
	Total	Fixed	Variable
HW-1 =	$150,377.00	$12,388.00	$137,989.00
HW-2 =	7,390.88	513.40	6,877.48
Totals -	$157,767.88	$12,901.40	$144,866.48

Notes: Cost per piece for HW-1 and 2 = $\frac{\$157,767.88}{7,840,000}$ = .0201

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Notch Painting Hand No. HW-1

Equipment (A)

Based on 2 shifts, 4000 hrs., hourly prod. 1960 and annual prod. 7,840,000

Item	Annual Costs Total	Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 68,992 x Rate 1.6 (B) =	$110,387.00	xx	$110,387.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 110,387 =	33,116.00	$ 9,935.00	23,181.00
b. Mach., Equip. & Tool	178.80	145.27	33.53
c. Occupancy = Proc. Space 510 (C) x Ratio 5 = 2550 sq. ft.			
Rent .80 x 2550 =	2,040.00	2,040.00	
Light .30 x 2550 =	765.00	76.50	688.50
Heat .10 x 2550 =	255.00	191.25	63.75
Subtotal - a, b, and c	$ 36,354.80	---	---
d. Miscellaneous = 10% x Subtotal 36,354.80 =	3,635.48		3,635.48
Total - a, b, c, and d	39,990.28	---	---
GRAND TOTALS	$150,377.00	$12,388.00	$137,989.00

Notes: (A) Notch Painting Tool, Bench & Stool. Cost for 17 station = $894.30.
(B) Based on 17.24 men per hour per 40 modules per hour for 4,000 hours annually.
(C) Based on process space for 17 stations.

$$\text{Cost per piece} = \frac{\$150,377}{7,840,000} = .0192$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Notch Paint Firing Hand No. HW-2

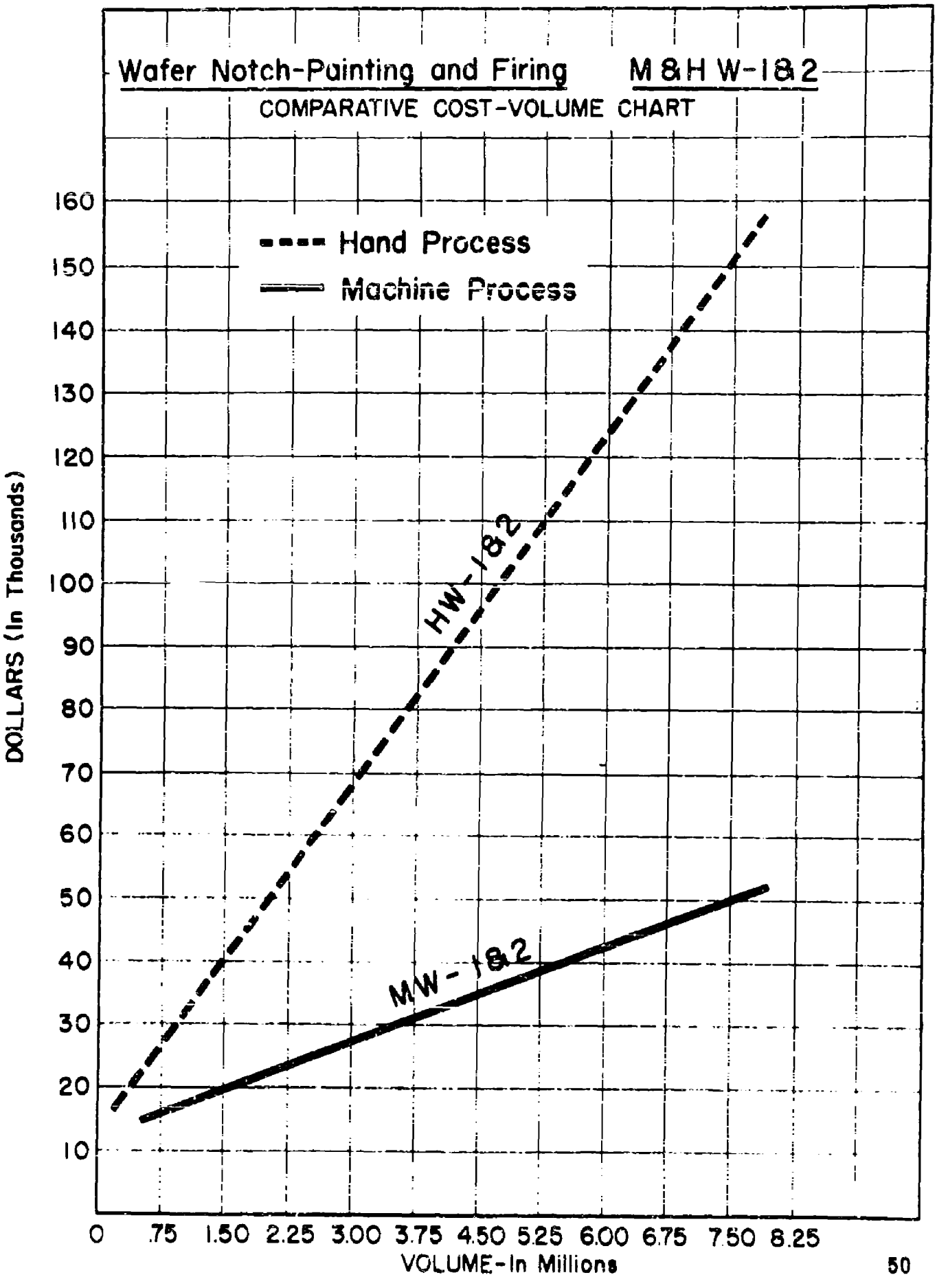
Equipment Benches, Stools and Infra-red Lamps

Based on 2 shifts, 4000 hrs., hourly prod. 1960 and annual prod. 7,840,000

Item	Total	Annual Cost Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 3,450 x Rate 1.6 =	$5,520.00	xx	$5,520.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30 % of Dir. 5,520 =	1,656.00	$477.00	1,179.00
b. Mach., Equip. & Tool	44.80	36.40	8.40
c. Occupancy = Process Space (A) x Ratio ____ =			
Subtotal - a, b, and c	$1,700.80	---	---
d. Miscellaneous = 10% x Subtotal 1,700.80 =	170.08		170.08
Total - a, b, c and d	1,870.88		
GRAND TOTAL	$7,390.88	$513.40	$6,877.48

Notes: (A) Part of operation HW-1 space used.

$$\text{Cost per piece} = \frac{\$7,390.88}{7,840,000} = .0009427$$


Wafer Notch-Painting and Firing M&H W-1&2
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HW-1&2
MW-1&2
DOLLARS (In Thousands)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
.75
1.50
2.25
3.00
3.75
4.50
5.25
6.00
6.75
7.50
8.25
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Wafer Pattern Printing, Firing, Test, Mach. No. MW-3, 4 & 5

Equipment See MW-3, 4 & 5 Data Sheet

Based on 2 shifts, 4,000 hrs., hourly prod. 2,225 and annual prod. 7,614,000

	Annual Cost		
	Total	Fixed	Variable
MW-3	$38,809	$ 9,014	$29,795
MW-4	4,758	2,826	1,932
MW-5	20,531	5,137	15,394
Total	$64,098	$16,977	$47,121

Notes:

Cost per piece for MW-3, 4 and 5 =

$$\frac{\$64,098}{7,614,000} = .00842$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Wafer Pattern Printing Mach. No. MW-3

Equipment 1 Wafer Pattern Printer (A)

Based on 2 shifts, 3,422 hrs., hrly. prod. 2,225 and annual prod. 7,614,000

		Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 4.80 (B) =	$19,200	xx	$19,200
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 19,200 =	5,760	$1,728	4,032
b. Mach., Equip. & Tool	10,983	5,611	5,372
c. Occupancy = Proc. Space 129 x Ratio 6 = 774 sq. ft.			
Rent 774 x 1.00 =	774	774	---
Light 774 x .30 =	232	23	209
Heat 774 x .10 =	77	58	19
Subtotal - a, b, and c	$17,826	$8,194	$ 9,632
d. Miscellaneous = 10% x Subtotal 17,826 =	1,783	820	963
Total - a, b, c, and d	19,609	9,014	10,595
GRAND TOTALS	$38,809	$9,014	$29,795

Notes:

(A) 1 Pattern printer @ $26,500

(B) 1 Skilled - $2.00
1 Semi-skilled - 1.60
1 Unskilled - 1.20
$4.80

Cost per piece = $\frac{\$38,809}{7,614,000} = .0051$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Wafer Pattern Firing Mach. No. MW-4

Equipment 1 Furnace (A)

Based on 2 shifts, 3422 hrs., hourly prod. 2,225 and annual prod. 7,614,000

Item	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. (B) x Rate _____ =	---	xx	---
3. Manufacturing Overhead			
a. Ind. Lab.			
b. Mach., Equip. & Tool	$3,132	$1,628	$1,504
c. Occupancy =			
Proc. Space 142 x Ratio 6 = 852 sq. ft.			
Rent 852 x 1.00 =	852	852	---
Light 852 x .30 =	256	26	230
Heat 852 x .10 =	85	63	22
Subtotal - a, b, and c	$4,325	$2,569	$1,756
d. Miscellaneous =			
10% x Subtotal 4,325 =	433	257	176
Total - a, b, c, and d	$4,758	$2,826	$1,932
GRAND TOTALS	$4,758	$2,826	$1,932

Notes:

(A) 1 Furnace @ $9,000

(B) Direct Labor Included in MW-3

Cost per piece = $\frac{\$4,758}{7,614,000} = .00062$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Wafer Pattern Testing Mach. No. MW-5

Equipment 1 Pattern Tester (A)

Based on 2 shifts, 3,470 hrs., hourly prod. 2,194 and annual prod. 7,614,000

	Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 2.40 (B) =	$9,600	xx	$9,600
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 9,600 =	2,880	$ 864	2,016
b. Mach. Equipment & Tool	6,796	3,599	3,197
c. Occupancy = Proc. Space 31 x Ratio 6 = 186 sq. ft.			
Rent 186 x 1.00 =	186	186	----
Light 186 x .30 =	56	6	50
Heat 186 x .10 =	19	15	4
Subtotal - a, b, and c	9,937	4,670	5,267
d. Miscellaneous = 10% of Subtotal 9,937 =	994	467	527
Total - a, b, c, and d	10,931	5,137	5,794
GRAND TOTALS	$ 20,531	$5,137	$ 15,394

Notes:

(A) 1 Tester @ $17,000
(B) 1 Highly skilled @ $2.40

Cost per piece = $\frac{\$20,531}{7,614,000} = .0027$

This operation is not performed separately in the hand process, but is included in steps HW 3 and 4.

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Wafer Pattern Printing & Firing Hand No. HW-3 & 4

Based on 2 shifts, 4000 hrs., hourly prod. 1800 and annual prod. 7,200,000

	Annual Cost		
	Total	Fixed	Variable
HW-3	$26,214.40	$3,602.63	$22,611.77
HW-4	9,688.29	1,439.60	8,248.69
	$35,902.69	$5,042.23	$30,860.46

Notes:

Cost per piece for HW-3 and 4 = $\frac{\$35,902.69}{7,200,000} = .00498$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Pattern Printing Hand No. HW-3

Equipment (A)

Based on 2 shifts, 4000 hrs., hourly prod. (B) 1800 and annual prod. (B) 7,200,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. (C) 11,016 x Rate 1.6	$17,625.60	xx	$17,625.60
3. Manufacturing Overhead			
a. Ind. Lab. = 30%	5,287.60	$1,586.30	3,701.30
b. Mach., Equip. & Tool	1,980.40	1,609.08	371.32
c. Occupancy			
Proc. Space (D) 90 x Ratio 5 = 450 sq. ft.	xx	xx	xx
Rent 450 x .80 =	360.00	360.00	
Light 450 x .30 =	135.00	13.50	121.50
Heat 450 x .10 =	45.00	33.75	11.25
Subtotal - a, b, and c	$ 7,808.00		
d. Miscellaneous = 10% x Subtotal =	780.80		780.80
Total - a, b, c, and d	8,588.80		
GRAND TOTALS	$26,214.40	$3,602.63	$22,611.77

Notes:

(A) Printing press, screens, bench & stool; cost for 3 stations = $9,902.20

(B) 15 ops. on one side x 40 = 600 ops/hr x 4000 hrs. = 2,400,000 ops (pcs)
30 ops. on two sides x 40 = 1200 ops/hr x 4000 hrs. = 4,800,000 ops (pcs)
1800 pcs/hr 7,200,000 pcs annual prod.

(C) .546 (Men/hr to make 40 Mod/hr) x 4000 hrs = 2,184 Dir. Lab. Hrs.
2.208 " x 4000 hrs = 8,832 "
11,016

(D) Based on 30 sq. ft. x 3 Stations (for both Ops) = 90 sq. ft.

Cost per piece = $26,214.40 / 7,200,000 = .00364

This cost is based on printing six wafers at one time instead of one as at present.

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Wafer Pattern Firing Hand No. HW-4

Equipment Curing Oven (A)

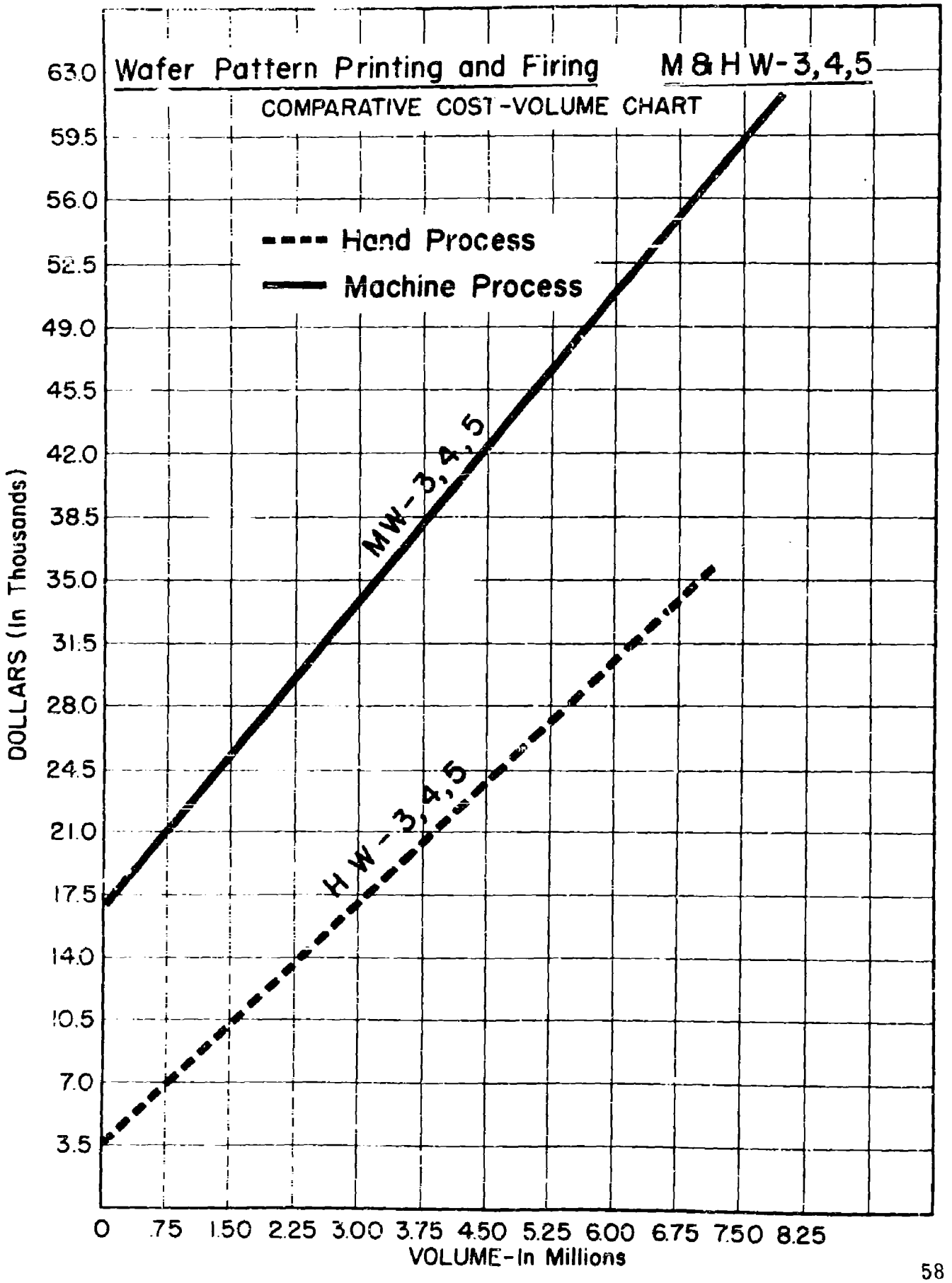
Based on 2 shifts, 4000 hrs., hourly prod. 1800 and annual prod. 7,200,000 (B)

Item	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3168 (C) x Rate 1.6 =	$5,068.80	xx	$5,068.80
3. Manufacturing Overhead			
a. Indirect Labor	1,520.64	$ 456.19	1,064.45
b. Mach., Equip. & Tool	2,472.50	827.75	1,644.75
c. Occupancy =			
Proc. Space 172 x Ratio 1 = 172 sq. ft.	xx	xx	xx
Rent 172 x .8 =	137.60	137.60	
Light 172 x .3 =	51.60	5.16	46.44
Heat 172 x .1 =	17.20	12.90	4.30
Subtotal - a, b, and c	$4,199.54		
d. Miscellaneous = 10% x Subtotal	419.95		419.95
Total - a, b, c, and d	4,619.49		
GRAND TOTALS	$9,688.29	$1,439.60	$8,248.69

Notes:

(A) Cost of equipment = $4,730
(B) 45 Wafers/module x 40 modules/hr = 1800 hrly prod. x 4,000 = annual prod.
(C) .7920 men per hr. per 40 strips x 4000 hrs. = 3,168

$$\text{Cost per piece} = \frac{\$9,688.29}{7,200,000} = .00134$$


Wafer Pattern Printing and Firing
M & H W-3,4,5
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
MW-3,4,5
HW-3,4,5
DOLLARS (In Thousands)
63.0
59.5
56.0
52.5
49.0
45.5
42.0
38.5
35.0
31.5
28.0
24.5
21.0
17.5
14.0
10.5
7.0
3.5
0
.75
1.50
2.25
3.00
3.75
4.50
5.25
6.00
6.75
7.50
8.25
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor Tape Application Mach. No. MR-1

Equipment 1 Resistor Tape Applicator (A)

Based on 2 shifts, 2,273 hrs., hourly prod. 1,069 and annual prod. 2,430,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 2,880 x Rate 1.60 (B) =	$ 4,608	xx	$4,608
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 4,608 =	1,382	$ 415	967
b. Mach., Equip. & Tool	4,762	2,541	2,221
c. Occupancy = Proc. Space 24 x Ratio 6 = 144 sq. ft.			
Rent 144 x 1.00 =	144	144	---
Light 144 x .30 =	43	4	39
Heat 144 x .10 =	14	12	2
Subtotal - a, b, and c	$ 6,345	$3,116	$3,229
d. Miscellaneous = 10% of Subtotal 6,345 =	635	312	323
Total - a, b, c, and d	6,980	3,428	3,552
GRAND TOTALS	$11,588	$3,428	$8,160

Notes:

(A) 1 Tape Applicator @ $12,000
(B) 1 Semi-skilled @ $1.60

Cost per piece = $\frac{\$11,588}{2,430,000} = .00477$

Appendix B
Schedule B-3b

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Resistor Tape Application & Inspec. Hand No. HR-1 & 1b

Equipment

Based on 2 shifts, 4,000 hrs., hourly prod. _____ wafers and annual prod. 2,400,000

	Annual Cost		
	Total	Fixed	Variable
HR-1	$27,358.19	$2,238.29	$25,119.90
HR-1b	29,012.72	2,540.65	26,472.07
Total	$56,370.91	$4,778.94	$51,591.97

Notes:

$$\text{Cost per piece} = \frac{\$56,370.91}{2,400,000 \text{ wafers}} = .0235$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Resistor Tape Application Hand No. HR-1

Equipment (A)

Based on 2 shifts, 4,000 hrs., hourly prod. (B) and annual prod. (C) 2,560,000

Item	Annual Costs Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. (D) 12,563.2 x Rate 1.6 =	$20,101.12	xx	$20,101.12
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 20,101.12 =	6,030.34	$1,809.10	4,221.24
b. Mach., Equip. & Tool	27.00	21.94	5.06
c. Occupancy =			
Proc. Space (E) 90 x Ratio 5 = 450 sq. ft.			
Rent 450 x .8 =	360.00	360.00	
Light 450 x .3 =	135.00	13.50	121.50
Heat 450 x .1 =	45.00	33.75	11.25
Subtotal - a, b, and c	6,597.34		
d. Miscellaneous =			
10% of Subtotal 6,597.34 =	659.73		659.73
Total - a, b, c, and d	7,257.07		
GRAND TOTALS	$27,358.19	$2,238.29	$25,119.90

Notes: (A) Bench, stool, cutting tools; cost for 3 stations - $135.00

(B) Use net 600 for comparative costs.

(C) 11 op's. on one side x 40 = 440/hr. x 4,000 = 1,760,000
5 op's. on two sides x 40 = 200/hr. x 4,000 = 800,000
2,560,000 pcs. annual prod.

(D) 1.9008 (men/hr. to make 40 mod./hr. x 4,000 hrs. = 7,603.2 dir. lab. hrs.
1.240 " " x 4,000 hrs. = 4,960.0 "
12,563.2

(E) Based on 30 sq. ft. per station x 3 stations = 90 sq. ft.

Cost per piece = $\frac{\$27,358.19}{2,560,000}$ = .0107

PROJECT TINKERTOY -- Manufacturing Cost Data

Proces: Curing Resistor Tape Hand No. HR-1a

Equipment *

Based on 2 shifts, 4000 hrs., hourly prod. 600 and annual prod. 2,400,000

	Total	Annual Costs Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 1,126.40 x Rate 1.6 =	$1,802.24	xx	$1,802.24
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 1,802.24 =	540.67	$162.20	378.47
b. Mach., Equip. & Tool	805.00	269.50	535.50
c. Occupancy = Proc. Space 56 x Ratio 5 = 280 sq. ft.			
Rent .8 x 280 =	224.00	224.00	---
Light .3 x 280 =	84.00	8.40	75.60
Heat .1 x 280 =	28.00	21.00	7.00
Subtotal - a, b, and c	$1,681.67		
d. Miscellaneous = 10% x Subtotal 1,681.67 =	168.17		168.17
Total - a, b, c, and d	1,849.84		
GRAND TOTALS	$3,652.08	$685.10	$2,966.98

Notes:

* Curing oven (used for other curing opers.; cost distr. on basis of pieces)

15 ops x 40 = hrly prod x 4,000 = 2,400,000 annual prod.

.28160 x 4,000 = 1,126.40 Dir. Lab. Hrs.

Cost per piece = $\frac{\$3,652.08}{2,400,000 \text{ pcs.}}$ = .00152

This operation is being performed in current model shop manufacture, but is not included in the projected hand process manufacture. The protective tape curing operation (HR-3) is included.

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Inspecting Resistor Tape Hand No. HR-1b

Equipment Benches, stools, elect. testing instr.

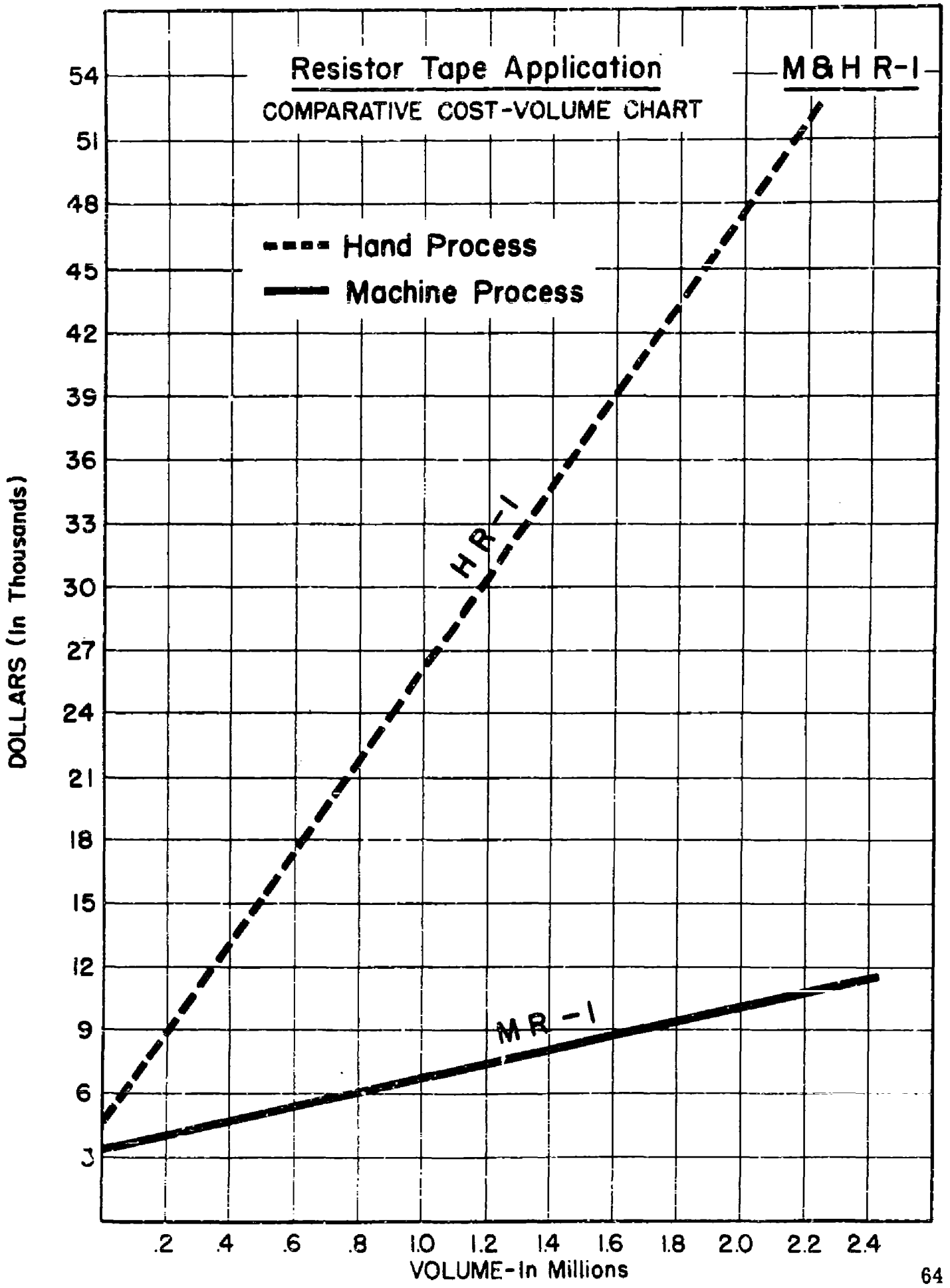
Based on 2 shifts, 4,000 hrs., hourly prod. 600 (640 Inspections) and annual prod. 2,400,000 (B) (2,560,000 Inspections)

	Total	Annual Cost Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 13,200 (C) x Rate 1.6	$21,120.00	xx	$21,120.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 21,120.00 =	6,336.00	$ 1,900.80	4,435.20
b. Mach., Equip. & Tool	119.20	96.85	22.35
c. Occupancy =			
Proc. Space 120 (D) x Ratio 5 = 600 Sq. ft.			
Rent .8 x 600 =	480.00	480.00	---
Light .3 x 600 =	180.00	18.00	162.00
Heat .1 x 600 =	60.00	45.00	15.00
Subtotal - a, b, and c	7,175.20		
d. Miscellaneous =			
10% x Subtotal 7,175.20 =	717.52		717.52
Total - a, b, c, and d	7,892.72		
GRAND TOTALS	$29,012.72	$2,540.65	$26,472.07

Notes:

(A) Cost of equipment for 4 stations = $596.
(B) 15 ops x 40 = 600 hrly prod x 4,000 = 2,400,000 annual prod.
(C) 3.30 x 4,000 = 13,200 Dir. Lab. Hrs.
(D) 4 stations x 30 sq. ft. = 120 sq. ft.

Cost per piece = $\frac{\$29,012.72}{2,400,000} = .0121$


Resistor Tape Application
COMPARATIVE COST-VOLUME CHART
M & H R-1
Hand Process
Machine Process
HR-1
MR-1
DOLLARS (In Thousands)
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Protective Tape Application Mach. No. MR-2

Equipment 1-Protective Tape Applicator (A)

Based on 2 shifts, 2275 hrs., hourly prod. 1069 and annual prod. 2,430,000

	Total	Annual Cost Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 2,880 x Rate 1.60 (B) =	$ 4,608.00	xx	$4,608.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 4,608 =	1,382.00	$ 415.00	967.00
b. Mach., Equip. & Tool	4,762.00	2,541.00	2,221.00
c. Occupancy =			
Proc. Space 24 x Ratio 6 = 144 sq. ft.			
Rent 1.00 x 144 =	144.00	144.00	---
Light .30 x 144 =	43.00	4.00	39.00
Heat .10 x 144 =	14.00	12.00	2.00
Subtotal - a, b, and c	$ 6,345.00	$3,116.00	$3,229.00
d. Miscellaneous = 10% x Subtotal 6,345 =	635.00	312.00	323.00
Total - a, b, c and d	6,980.00	3,428.00	3,552.00
GRAND TOTAL	$11,588.00	$3,428.00	$8,160.00

Notes:

(A) 1 Tape applicator = $12,000
(B) 1 Semi-skilled = $1.60

Cost per piece = $\frac{\$11,588}{2,430,000}$ = .00477

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor Protective - Tape Application Hand No. HR-2

Equipment (A)

Based on 2 shifts, 4000 hrs., hourly prod. (B) 600 and annual prod. 2,400,000 (B)

	Total	Annual Costs Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. (C) 15,488 x Rate 1.6 =	$24,780.80	xx	$24,780.80
3. Manufacturing Overhead			
a. Ind. Lab. = 30%	7,434.24	$2,230.27	5,203.97
b. Mach., Equip. & Tool	49.20	39.98	9.22
c. Occupancy = Proc. Space (D) 120 x Ratio 5 = 600 sq. ft.			
Rent .80 x 600 =	480.00	480.00	---
Light .30 x 600 =	180.00	18.00	162.00
Heat .10 x 600 =	60.00	45.00	15.00
Subtotal - a, b, and c	$ 8,203.44	---	---
d. Miscellaneous = 10% x Subtotal	820.34	---	820.34
Total - a, b, c, and d	9,023.78	---	---
GRAND TOTAL	$33,804.58	$2,813.25	$30,991.33

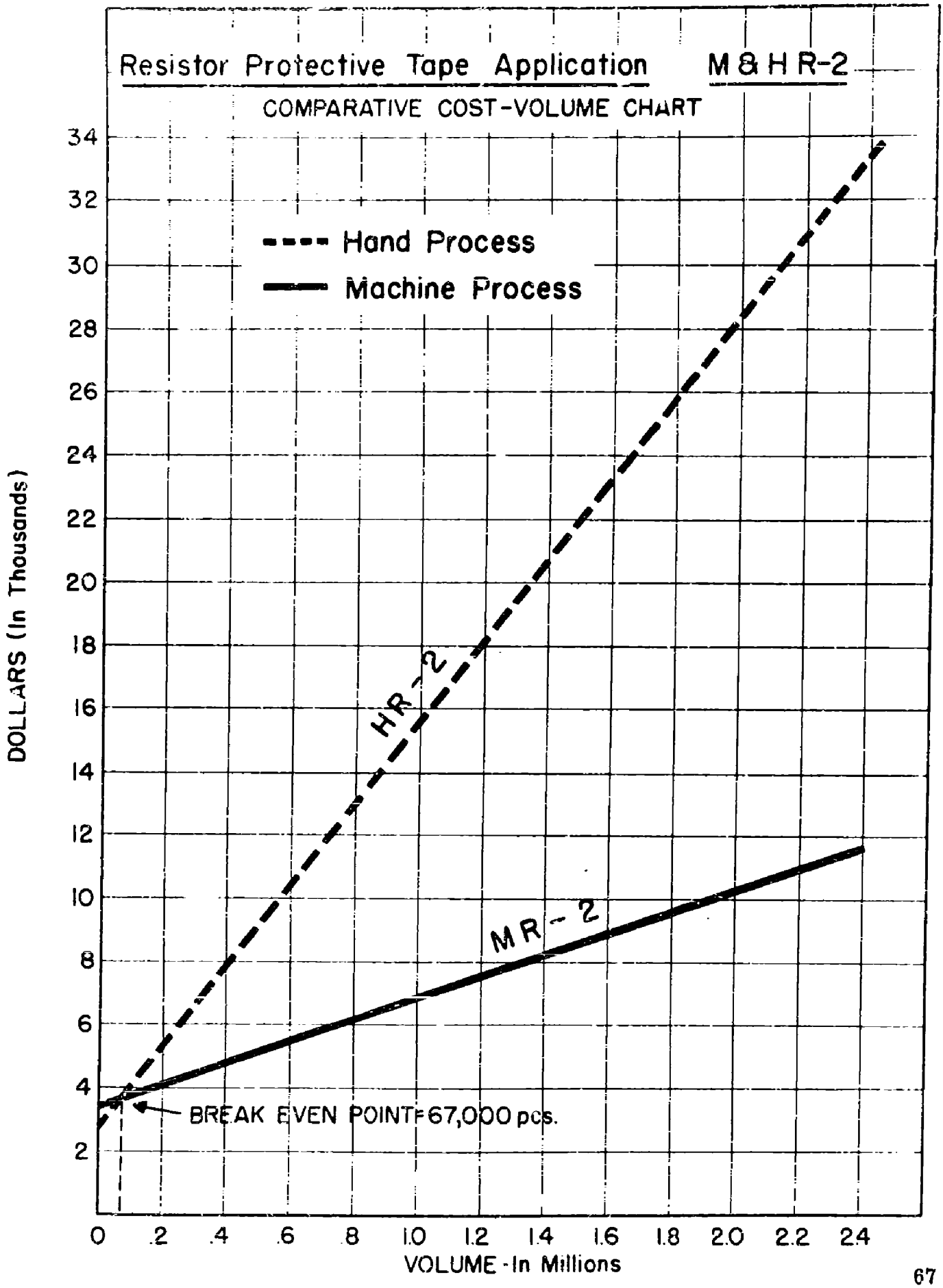
Notes: (A) Tape Press, Bench, Stool; cost for 4 stations = $246.40

(B) 7 operators on one side x 40 = 280 x 4000 = 1,120,000
8 operators on two sides x 40 = 320 x 4000 = 1,280,000
600 2,400,000 pcs. Annual Prod.

(C) 1.3664 (men/hr to make 40 modules/hr) x 4000 hrs = 5,465.6) Direct
10,022.4) Labor
15,488.0) Hrs.

(D) Based on 30 sq. ft. per station x 4 stations = 120 sq. ft.

$$\text{Cost per piece} = \frac{\$33,804.58}{2,400,000} = .0141$$


Resistor Protective Tape Application M & H R-2
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HR-2
MR-2
BREAK EVEN POINT=67,000 pcs.
DOLLARS (In Thousands)
VOLUME - In Millions
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor and Protective Tape Curing Mach. No. MR-3

Equipment 1 Oven (A)

Based on 2 shifts, 2,273 hrs., hourly prod. 1,069 and annual prod. 2,430,000

	Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. (B) x Rate =	---	xx	---
3. Manufacturing Overhead			
a. Ind. Lab. = ____% of Dir. =	---	--	---
b. Mach., Equip. & Tool	$2,588	$1,628	$ 960
c. Occupancy =			
Proc. Space 60 x Ratio 6 = 360 sq. ft.			
Rent 360 x 1.00 =	360	360	---
Light 360 x .30 =	108	11	97
Heat 360 x .10 =	36	27	9
Subtotal - a, b, and c	$3,092	$2,026	$1,066
d. Miscellaneous =			
10% x Subtotal 3,092 =	309	203	106
Total - a, b, c, and d			
GRAND TOTALS	$3,401	$2,229	$1,172

Notes:

(A) 1 Oven = $9,000
(B) Direct Labor included in MR-2

Cost per piece = $\frac{\$3,401}{2,430,000} = .00141$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Curing Protective Tape Hand No. HR-3

Equipment Oven (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 600 wafers and annual prod. 2,400,000 wafers (B)

	Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 1,126.40 (C) x Rate 1.6 =	$1,802.24	xx	$1,802.24
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 1,802.24 =	540.67	$ 162.20	378.47
b. Mach., Equip. & Tool	805.00	685.30	119.70
c. Occupancy = Proc. Space 56 * x Ratio 5 = 280 sq. ft.			
Rent 280 x .8 =	224.00	224.00	---
Light 280 x .3 =	84.00	8.40	75.60
Heat 280 x .1 =	28.00	21.00	7.00
Subtotal - a, b, and c	$1,681.67		
d. Miscellaneous = 10% x Subtotal 1,681.67 =	168.17		168.17
Total - a, b, c, and d	1,849.84		
GRAND TOTALS	$3,652.08	$1,100.90	$2,551.18

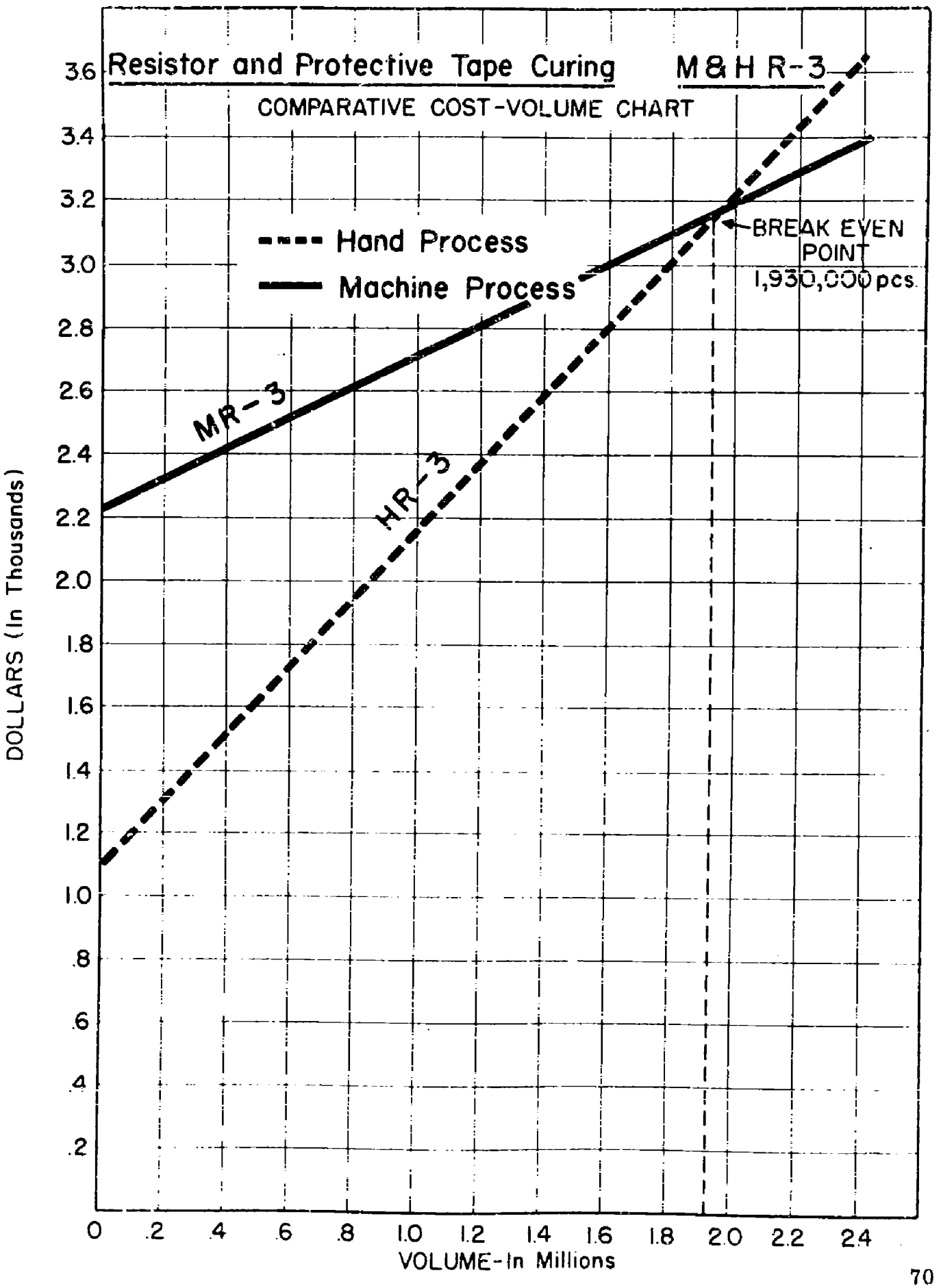
Notes:

* Pro Rata

(A) Cost of Equipment = $1,540
(B) 16 opers x 40 = 640 hrly. prod. x 4,000 = 2,560,000 annual prod. (ops.)
(C) .28160 x 4,000 = 1,126.40 Dir. Lab. Hrs.

Cost per operation = $\frac{\$3,652.08}{2,560,000 \text{ ops}} = .00143$

Cost per wafer = $\frac{\$3,652.08}{2,400,000 \text{ wafers}} = .00152$


Resistor and Protective Tape Curing
M & H R-3
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
BREAK EVEN POINT
1,930,000 pcs.
MR-3
HR-3
DOLLARS (In Thousands)
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor Wafer Notch Solder Filling Mach. No. MR-4

Equipment 2 Notch Tinners (A)

Based on 2 shifts, 2,978 hrs., hourly prod. 816 and annual prod. 2,430,000

	Total	Annual Costs Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3,600 x Rate 2.40 (B) =	$ 8,640	xx	$ 8,640
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 8,640 =	2,592	$ 778	1,814
b. Mach., Equip. & Tool	4,743	2,435	2,308
c. Occupancy =			
Proc. Space 50 x Ratio 6 = 300 sq. ft.			
Rent 300 x 1.00 =	300	300	---
Light 300 x .30 =	90	9	81
Heat 300 x .10 =	30	24	6
Subtotal - a, b, and c	$ 7,755	$3,546	$ 4,209
d. Miscellaneous =			
10% x Subtotal 7,755 =	776	355	421
Total - a, b, c, and d	8,531	3,901	4,630
GRAND TOTALS	$17,171	$3,901	$13,270

Notes:

(A) 2 Tinners @ $5,750 = $11,500
(B) 2 Unskilled @ $1.20 = $2.40

$$\text{Cost per piece} = \frac{\$17,171}{2,430,000} = .00707$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor-Wafer Notch Solder Filling Hand No. HR-4

Equipment (A)

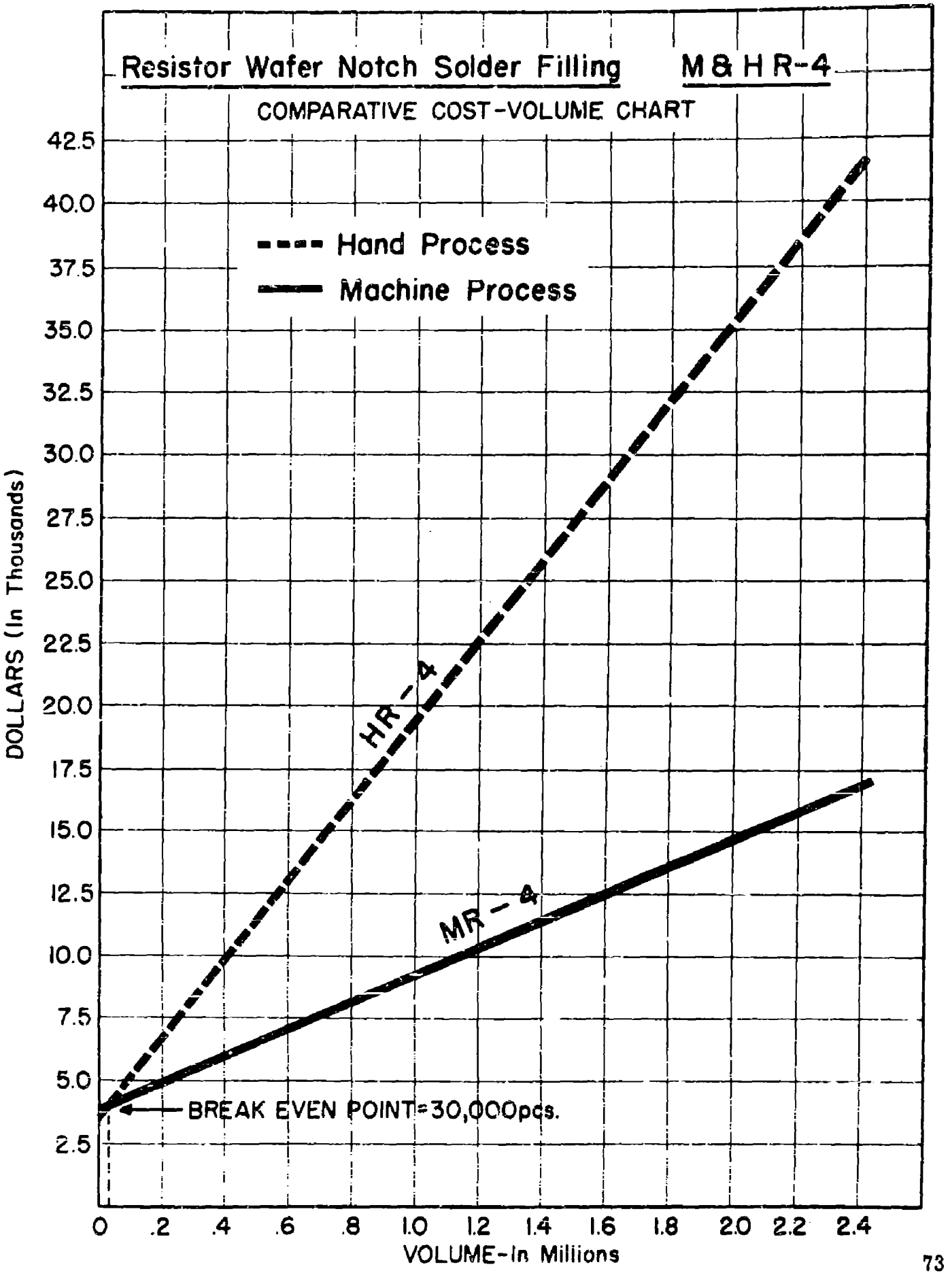
Based on 2 shifts, 4000 hrs., hourly prod. 600 and annual prod. 2,400,000 (B)

		Annual Costs		
	Total	Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 19,008 (C) x Rate 1.6 =	$30,412.80	xx	$30,412.80
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 30,412.80	9,123.84	$2,737.15	6,386.69
b. Mach., Equip. & Tool	187.60	152.43	35.17
c. Occupancy = Proc. Space 150 (D) x Ratio 5 = 750 sq. ft.			
Rent .8 x 750 =	600.00	600.00	
Light .3 x 750 =	225.00	25.00	200.00
Heat .1 x 750 =	75.00	56.25	18.75
Subtotal - a, b, and c	$10,211.44		
d. Miscellaneous = 10% x Subtotal 10,211.44 =	1,021.14		
Total - a, b, c, and d	11,232.58		
GRAND TOTALS	$41,645.38	$3,570.83	$38,074.55

Notes:

(A) Solder pots, cleaning & rinsing pans, bench, stool, tweezers, hood. Cost of equipment - $938.
(B) 15 ops x 40 = 600/hr x 4,000 = 2,400,000
(C) 4.752 x 4,000 = 19,008 Dir. Lab. Hrs.
(D) 5 stations x 30 sq. ft. = 150 sq. ft.

$$\text{Cost per piece} = \frac{\$41,645.38}{2,400,000 \text{ pcs}} = .0174$$


Resistor Wafer Notch Solder Filling M & H R-4
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HR-4
MR-4
BREAK EVEN POINT=30,000pcs.
DOLLARS (In Thousands)
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor Inspection Mach. No. MR-5

Equipment 2 Resistor Assembly Testers (A)

Based on 2 shifts, 2,490 hrs., hourly prod. 976 and annual prod. 2,430,000

	Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3,086 x Rate 4.80 (B) =	$14,784	xx	$14,784
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 14,784	4,435	$1,331	3,104
b. Mach., Equip. & Tool	8,821	4,658	4,163
c. Occupancy = Proc. Space 82 x Ratio 6 = 492 sq. ft.			
Rent 492 x 1.00 =	492	492	---
Light 492 x .30 =	148	15	133
Heat 492 x .10 =	49	36	13
Subtotal - a, b, and c	$13,945	$6,532	$ 7,413
d. Miscellaneous = 10% x Subtotal 13,945 =	1,395	653	742
Total - a, b, c, and d	15,340	7,185	8,155
GRAND TOTALS	$30,124	$7,185	$22,939

Notes:

(A) 2 Testers @ $11,000 = $22,000
(B) 2 Highly Skilled @ $2.40 = $4.80

Cost per piece = $\frac{\$30,124}{2,430,000} = .0124$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Resistor Inspection Hand No. HR-5

Equipment Benches, stools, testing equipment

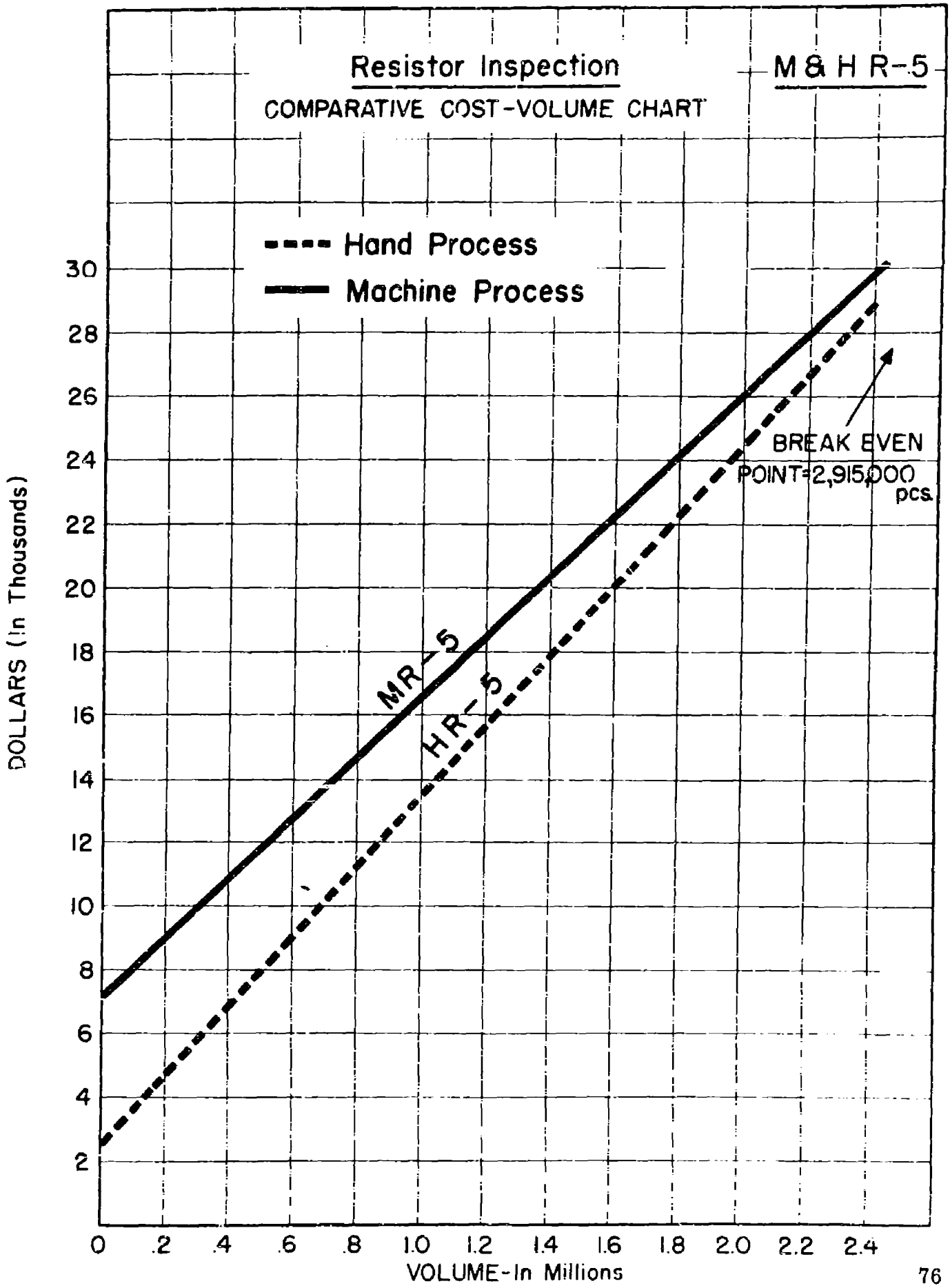
Based on 2 shifts, 4000 hrs., hourly prod. 600 and annual prod. 2,400,000

	Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 13,200 x Rate 1.6 =	$21,120.00	xx	$21,120.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 21,120.00	6,336.00	$1,900.80	4,435.20
b. Mach., Equip. & Tool	95.40	77.51	17.89
c. Occupancy = Proc. Space 120 x Ratio 5 = 600 sq. ft.			
Rent .8 x 600 =	480.00	480.00	
Light .3 x 600 =	180.00	18.00	162.00
Heat .1 x 600 =	60.00	45.00	15.00
Subtotal - a, b, and c	$ 7,151.40		
d. Miscellaneous = 10% of Subtotal 7,151.40	715.14		715.14
Total - a, b, c, and d	7,866.54		
GRAND TOTALS	$28,986.54	$2,521.31	$26,465.23

Notes:

15 ops x 40 = 600 ops/m x 4,000 = 2,400,000 annual prod.
3.3 x 4,000 = 13,200 Dir. Lab. Hrs.
4 stations x 30 sq. ft. = 120
Cost of equipment = $477

$$\text{Cost per piece} = \frac{\$28,986.54}{2,400,000} = .0121$$


Resistor Inspection
M & H R-5
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
BREAK EVEN
POINT=2,915,000
pcs.
MR-5
HR-5
DOLLARS (In Thousands)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Capacitor Wafer Pattern Tinning Mach. No. MC-1

Equipment 3-Surface Tinners (A)

Based on 2 shifts, 4000 hrs., hourly prod. 1276 and annual prod. 5,184,000 (B)

	Annual Cost		
	Total	Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 4000 x Rate 4.80 (C) =	$19,200	xx	$19,200
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 19,200 =	5,760	$1,728	4,032
b. Mach., Equip. & Tool	3,732	3,420	312
c. Occupancy = Proc. Space 66 x Ratio 6 = 396 sq. ft.			
Rent 396 x 1.00 =	396	396	---
Light 396 x .30 =	119	12	107
Heat 396 x .10 =	40	30	10
Subtotal - a, b, and c	$10,047	$5,586	$ 4,461
d. Miscellaneous = 10% x Subtotal 10,047 =	1,005	559	446
Total - a, b, c, and d	11,052	6,145	4,907
GRAND TOTALS	$30,252	$6,145	$24,107

Notes:

(A) 3-Surface Tinners @ $7,600 for capacitor and tube socket pattern tinning.

(B) This total is composed of:
Capacitor wafers = 3,390,000
Tube socket wafers = 1,794,000

(C) 3 Semi-skilled @ $1.60 = $4.80

$$\text{Cost per piece} = \frac{\$30,252}{5,184,000} = .00584$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Capacitor Wafer Pattern Tinning Hand No. HC-1

Equipment (A)

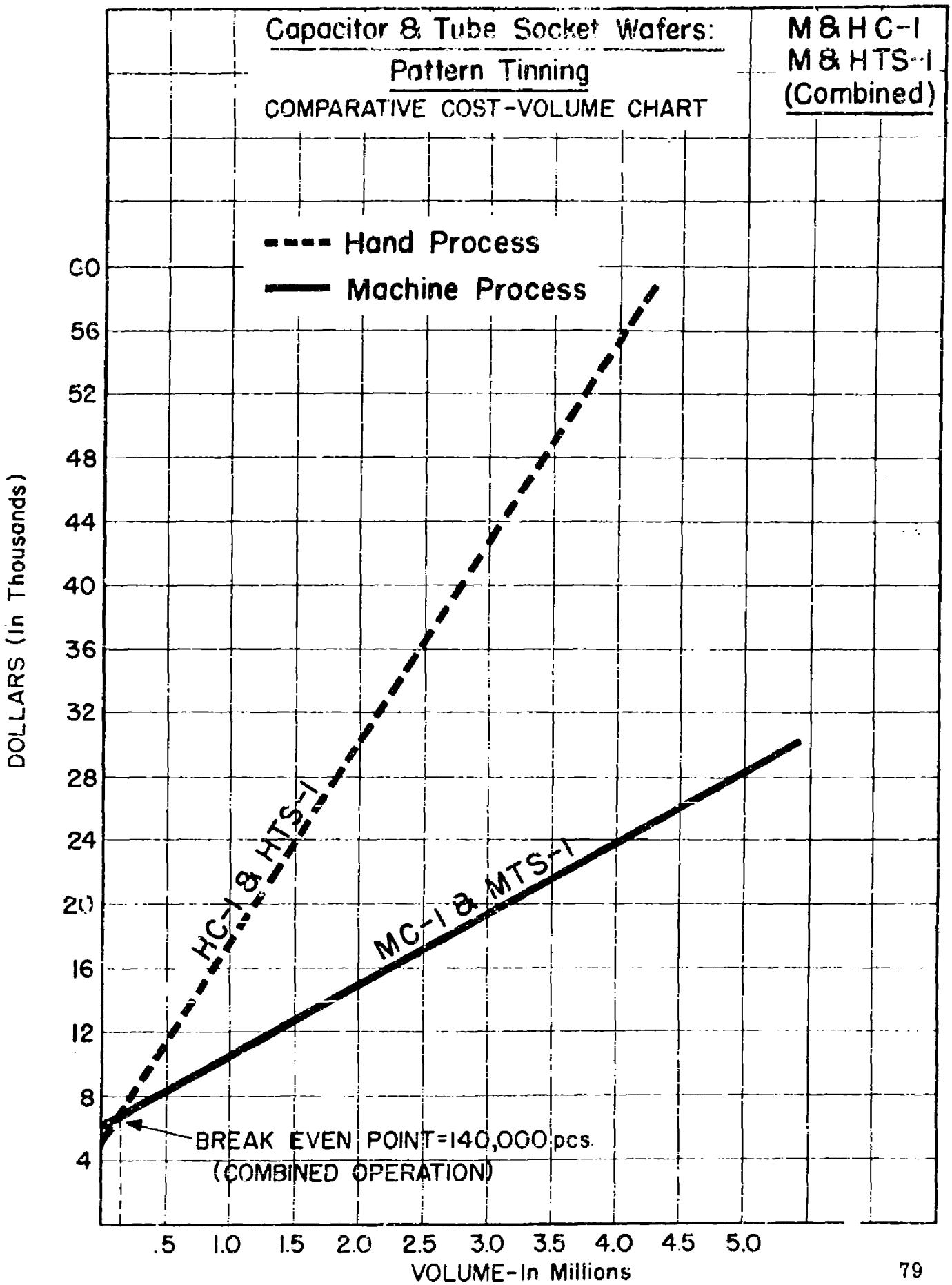
Based on 2 shifts, 4000 hrs., hourly prod. 720 (B) and annual prod. 2,880,000

	Annual Cost		
	Total	Fixed	Variable
1. Material	---	xx	---
2. Direct Labor = Hrs. 18,374 (C) x Rate 1.6 =	$29,399.00	xx	$29,399.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 29,399 =	8,819.70	$2,645.91	6,173.79
b. Mach., Equip. & Tool	187.60	152.43	35.17
c. Occupancy = Proc. Space 150 (D) x Ratio 5 = 750 sq. ft.			
Rent .80 x 750 =	600.00	600.00	
Light .30 x 750 =	225.00	22.50	202.50
Heat .10 x 750 =	75.00	56.25	18.75
Subtotal - a, b, and c	$ 9,907.30	---	---
d. Miscellaneous = 10% x Subtotal 9,907.30 =	990.73	---	990.73
Total - a, b, c and d	10,898.03		
GRAND TOTALS	$40,297.03	$3,477.09	$36,819.94

Notes: (A) Solder pots, tweezers, overhead hood, bench and stool. Cost for 5 stations = $938.
(B) 18 wafers/module x 40 modules/hr = 720/hr
(C) 4.5936 men/hr for 40 modules/hr x 4000 hrs = 18,374 hrs
(D) 5 stations required @ 30 sq. ft. each = 150 sq. ft.

$$\text{Cost per piece} = \frac{\$40,297.03}{2,880,000} = .014$$

The following chart, Schedule B-8c, reflects the combined capacitor and tube socket pattern tinning operations. (See B-8a, and B-15a)


Capacitor & Tube Socket Wafers:
Pattern Tinning
COMPARATIVE COST-VOLUME CHART
M & H C-1
M & H TS-1
(Combined)
Hand Process
Machine Process
DOLLARS (In Thousands)
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4
HC-1 & HTS-1
MC-1 & MTS-1
BREAK EVEN POINT=140,000 pcs.
(COMBINED OPERATION)
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Painting and Firing Mach No. MC-2 & 3

Equipment See MC-2 & 3 Data Sheets

Based on 2 Shifts, 3840 Hrs., Hourly prod. 1350 and annual prod. 5,184,000 bodies

		Annual Costs		
		Total	Fixed	Variable
	MC-2	$26.493.00	$6,348.00	$20,145.00
	MC-3	5,258.00	2,724.00	2,534.00
TOTAL		$31,751.00	$9,072.00	$22,679.00

Notes:

Cost per piece for MC-2 and 3 = $\frac{\$31,751.00}{5,184,000} = .00612$

Appendix B
Schedule B-9b

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Painter Mach. No. MC-2

Equipment 2-Capacitor Body Pattern Painters (A)

Based on 2 Shifts, 3840 Hrs., Hourly Prod. 1350 and annual Prod. 5,184,000 Bodies

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4000 x Rate 3.80 (B) =	$12,800	xx	$12,800
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Direct $12,800	3,840	$1,152	2,688
b. Mach., Equip. & Tool	8,121	4,234	3,887
c. Occupancy =			
Proc. space 58 x Ratio 6 = 348			
Rent 348 x $1.00 =	348	348	
Light " x .30 =	104	10	94
Heat " x .10 =	35	27	8
Subtotal - a, b, and c.	12,448	5,771	6,677
d. Miscellaneous =			
10% x Subtotal $12,448	1,245	577	668
Total - a, b, c, and d	13,693	6,348	7,345
GRAND TOTALS	$26,493	$6,348	$20,145

Notes:

(A) 2 Printers at $10,000 = $20,000
(B) 2 Semi-skilled at $1.60 = $3.20

Cost per piece = $\frac{\$26,493}{5,184,000}$ = .00511

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Firing Mach. No. MC-3

Equipment 1-Furnace (A)

Based on 2 shifts, 3840 hrs., hourly prod. 1350 and annual prod. 5,184,000

Item	Annual Costs Total	Fixed	Variable
1. Material			
2. Direct Labor = (B)			
3. Manufacturing Overhead			
a. Ind. Lab.			
b. Machine, Equipment & Tool	$,705	$1,628	$2,077
c. Occupancy =			
Proc. Space 128 x Ratio 6 = 768 sq.ft			
Rent 768 x 1.00 =	768	768	
Light 768 x .30 =	230	23	207
Heat 768 x .10 =	77	57	20
Subtotal - a, b, and c	4,780	2,476	2,304
d. Miscellaneous =			
10% x Subtotal 4780 =	478	248	230
Total - a, b, c, and	5,258	2,724	
GRAND TOTALS	$5,258	$2,724	$2,534

Notes: (A) Furnace @ $9.00 (Also used for MW-2, Wafer Notch Paint Firing.)
(B) Direct Labor in Operation MC-2.

Cost per piece = $\frac{\$5,258}{5,184,000} = .00101$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Printing & Firing Hand No. HC-2, 2a & 3

Equipment See HC-2, 2a & 3 Data Sheets

Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 and annual prod. 5,440,000

	Annual Cost		
	Total	Fixed	Variable
HC-2	$24,916.86	$3,148.89	$21,767.97
HC-2a	6,586.72	582.85	6,003.87
HC-3	7,543.46	1,417.68	6,125.78
GRAND TOTALS	$39,047.04	$5,149.42	$33,897.62

Notes:

Cost per piece for HC2, 2a & 3 =

$$\frac{\$39,047.04}{5,440,000} = .00717$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Printing Hand No. HC-2

Equipment (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 and annual prod. 5,440,000 (B)

		Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 10,662 (C) x Rate 1.6 =	$17,060	xx	$17,060
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Direct 17,060 =	5,118	$1,535.40	3,582.60
b. Mach., Equip. & Tool	1,484.60	1,206.24	278.36
c. Occupancy = Proc. Space 90 (D) x Ratio 5 = 450 sq. ft.			
Rent 450 x .80 =	360.00	360.00	---
Light 450 x .30 =	135.00	13.50	121.50
Heat 450 x .10 =	45.00	33.75	11.25
Subtotal - a, b, and c	$ 7,142.60		
d. Miscellaneous = 10% of Subtotal 7,142.60 =	714.26	---	714.26
Total - a, b, c, and d	7,856.86		
GRAND TOTALS	$24,916.86	$3,148.89	$21,767.97

Notes:

(A) Capacitor Printing Press, Syntron, Rack, Bench & Stool
Cost for 3 stations = $7,423.

(B) 34 x 40 = 1,360 hrly. prod. x 4,000

(C) 2.66560 x 4,000 = 10,662 Dir. Lab. Hrs.

(D) 3 stations x 30 sq. ft. = 90 sq. ft.

Cost per piece = $\frac{\$24,916.86}{5,440,000}$ = .00458

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Make Capacitor Leads Hand No. HC-2a

Equipment Benches, stools, fixture (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 and annual prod. 5,440,000 (B)

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 2,992 (C) x Rate 1.6 =	$4,787.20	xx	$4,787.20
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 4,787.20 =	1,436.16	$430.85	1,005.31
b. Mach., Equip. & Tool	20.00	16.25	3.75
c. Occupancy =			
Proc. Space 30(D) x Ratio 5 = 150 sq. ft.			
Rent 150 x .80 =	120.00	120.00	---
Light 150 x .30 =	45.00	4.50	40.50
Heat 150 x .10 =	15.00	11.25	3.75
Subtotal - a, b, and c	$1,636.16		
d. Miscellaneous =			
10% of Subtotal 1,636.16 =	163.36		163.36
Total - a, b, c, and d	1,799.52		
GRAND TOTALS	$6,586.72	$582.85	$6,003.87

Notes: (A) Equipment for one station = $100.
(B) 34 x 40 = 1,360 hrly. prod. x 4,000
(C) .74800 x 4,000 = 2,992 Dir. Lab. Hrs.

Cost per piece = $\frac{\$6,586.72}{5,440,000}$ = .00121

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Firing Hand No. HC-3

Equipment 1 Oven (A)

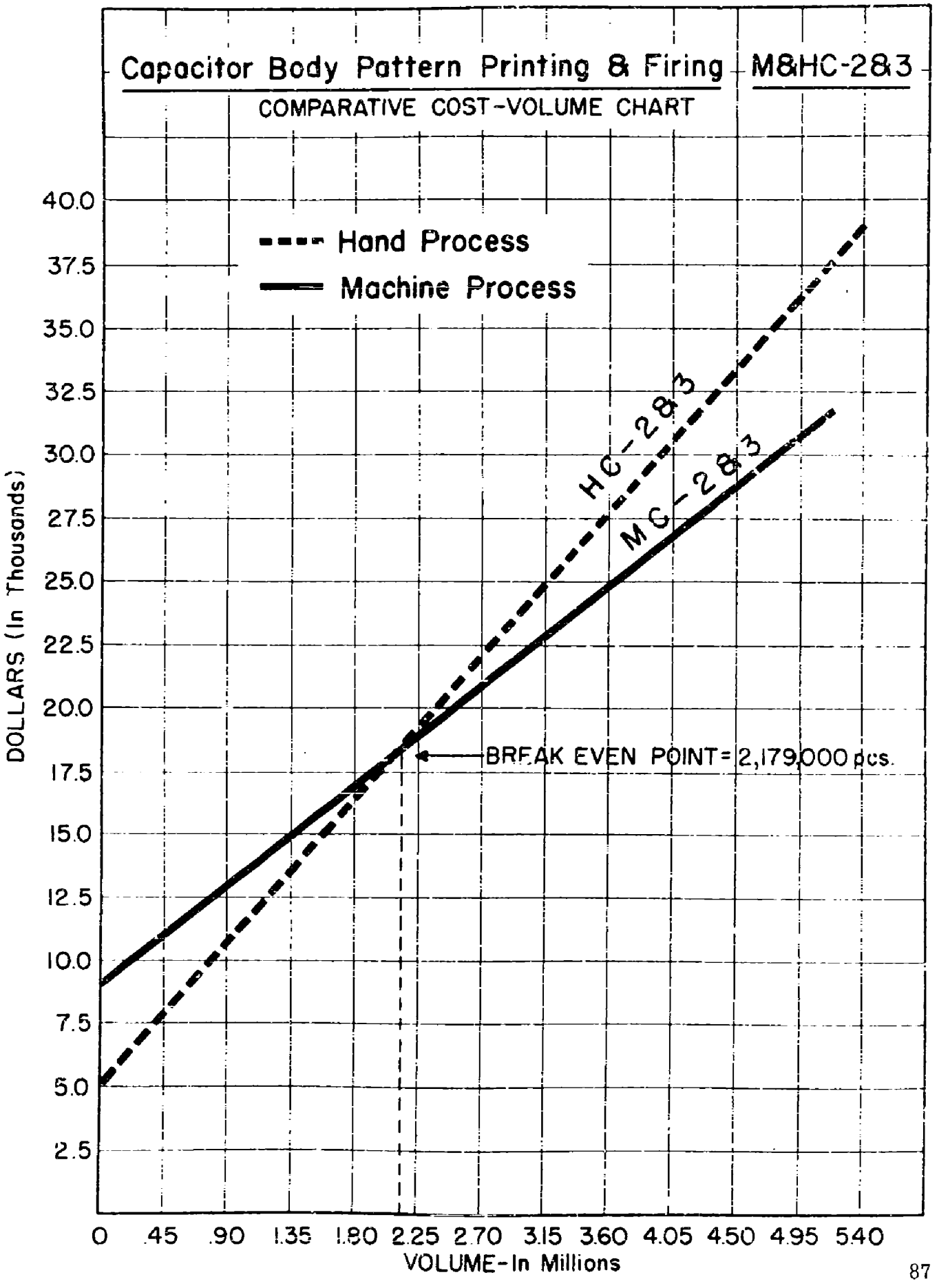
Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 and annual prod. 5,440,000 (B)

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 2,323 (C) x Rate 1.6 =	$3,717.00	xx	$3,717.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 3,717 =	1,115.10	$ 334.53	780.57
b. Mach., Equip. & Tool	1,667.50	558.25	1,109.25
c. Occupancy = Proc. Space 116 (D) x Ratio 5 = 580 sq. ft.			
Rent 580 x .80 =	464.00	464.00	---
Light 580 x .30 =	174.00	17.40	156.60
Heat 580 x .10 =	58.00	43.50	14.50
Subtotal - a, b, and c	$3,478.60		
d. Miscellaneous = 10% x Subtotal 3,478.60 =	347.86	---	347.86
Total - a, b, c, and d	3,826.46		
GRAND TOTALS	$7,543.46	$1,417.68	$6,125.78

Notes:

(A) 1 oven @ $3,190.
(B) 34 x 40 = 1,360 x 4,000
(C) .58080 x 4,000 = 2,323 Dir. Lab. Hrs.
(D) This is oven area, in which is included all associated space requirements.

Cost per piece = $\frac{\$7,543.46}{5,440,000} = .00138$


Capacitor Body Pattern Printing & Firing M&HC-283
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HC-283
MC-283
BREAK EVEN POINT = 2,179,000 pcs.
DOLLARS (In Thousands)
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
.45
.90
1.35
1.80
2.25
2.70
3.15
3.60
4.05
4.50
4.95
5.40
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitator Body Pattern Testing Mach. No. MC-4

Equipment 1 Capacitor Body Pattern Tester (A)

Based on 2 shifts, 3,134 hrs., hourly prod. 1,654 and annual prod. 5,184,000

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3,720 x Rate 2.40 (B)	$8,928	xx	$8,928
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 8,928 =	2,678	$ 803	1,875
b. Mach., Equip. & Tool	2,239	1,165	1,074
c. Occupancy = Proc. Space 17 x Ratio 6 = 102 sq. ft.			
Rent 102 x 1.00 =	102	102	---
Light 102 x .30 =	31	3	28
Heat 102 x .10 =	10	9	1
Subtotal - a, b, and c	5,060	$2,082	$2,078
d. Miscellaneous = 10% x Subtotal 5,060 =	506	208	298
Total - a, b, c and d	5,566	2,290	3,276
GRAND TOTALS	$14,494	$2,290	$12,204

Notes: (A) 1 Tester @ $5,500
(B) 1 Highly Skilled @ $2.40

Cost per piece = $\frac{\$14,494}{5,184,000} = .0028$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Testing Hand No. HC-4

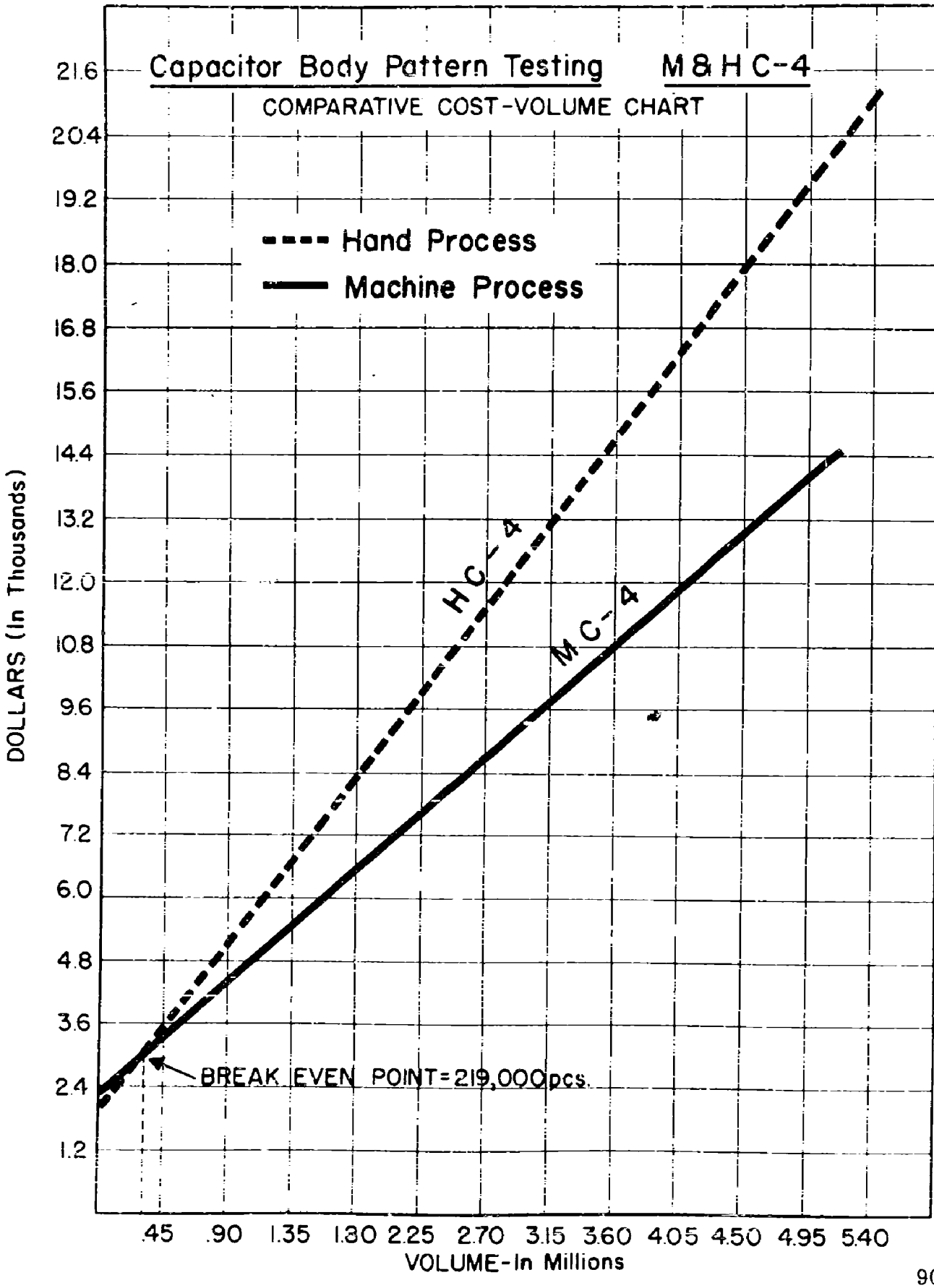
Equipment Benches, stools, electric tester (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 and annual prod. 5,440,000 (B)

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 9,574 (C) x Rate 1.6 =	$15,319	xx	$15,319
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 15,319 =	4,595.70	$1,378.71	3,216.99
b. Mach., Equip. & Tool	324.00	263.25	60.75
c. Occupancy = Proc. Space 90(D) x Ratio 5 = 450 sq. ft.			
Rent 450 x .80 =	360.00	360.00	---
Light 450 x .30 =	135.00	13.50	121.50
Heat 450 x .10 =	45.00	33.75	11.25
Subtotal - a, b, and c	5,459.70		
d. Miscellaneous = 10% x Subtotal 5,459.70 =	545.97		545.97
Total - a, b, c, and d	6,005.67		
GRAND TOTALS	$21,324.67	$2,049.21	$19,275.46

Notes: (A) Equipment for 3 stations = $1,620
(B) 34 x 40 = 1,360 pcs./hr. x 4,000 = 5,440,000
(C) 2.39360 x 4,000 = 9,574
(D) 3 stations x 30 sq. ft. = 90 sq. ft.

$$\text{Cost per piece} = \frac{\$21,324.67}{5,440,000 \text{ pcs.}} = .00392$$


Capacitor Body Pattern Testing M & H C-4
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HC-4
MC-4
BREAK EVEN POINT=219,000pcs.
DOLLARS (In Thousands)
21.6
20.4
19.2
18.0
16.8
15.6
14.4
13.2
12.0
10.8
9.6
8.4
7.2
6.0
4.8
3.6
2.4
1.2
.45
.90
1.35
1.80
2.25
2.70
3.15
3.60
4.05
4.50
4.95
5.40
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Tinning Mach. No. MC-5

Equipment 4 Capacitor Body Pattern Tinners (A)

Based on 2 shifts, 3,306 hrs., hourly prod. 1,568 and annual prod. 5,184,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3,880 x Rate 6.40 (B) =	$24,832	xx	$24,832
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 24,832 =	7,453	$ 2,236	5,217
b. Mach., Equip. & Tool	12,409	6,436	5,973
c. Occupancy = Proc. Space 92 x Ratio 6 = 552 sq. ft.			
Rent 552 x 1.00 =	552	552	---
Light 552 x .30 =	166	17	149
Heat 552 x .10 =	55	42	13
Subtotal - a, b, and c	$20,635	$ 9,283	$11,352
d. Miscellaneous = 10% x Subtotal 20,635 =	2,064	928	1,136
Total - a, b, c, and d	22,699	10,211	12,488
GRAND TOTALS	$47,531	$10,211	$37,320

Notes:

(A) 4 Tinners @ $7,600 = $30,400
(B) 4 Semi-skilled @ $1.60 = $6.40

Cost per piece = $\frac{\$47,531}{5,184,000}$ = .00917

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body Pattern Tinning Hand No. HC-5

Equipment Benches, stools, solder pots, exhaust hood, & misc. (A)

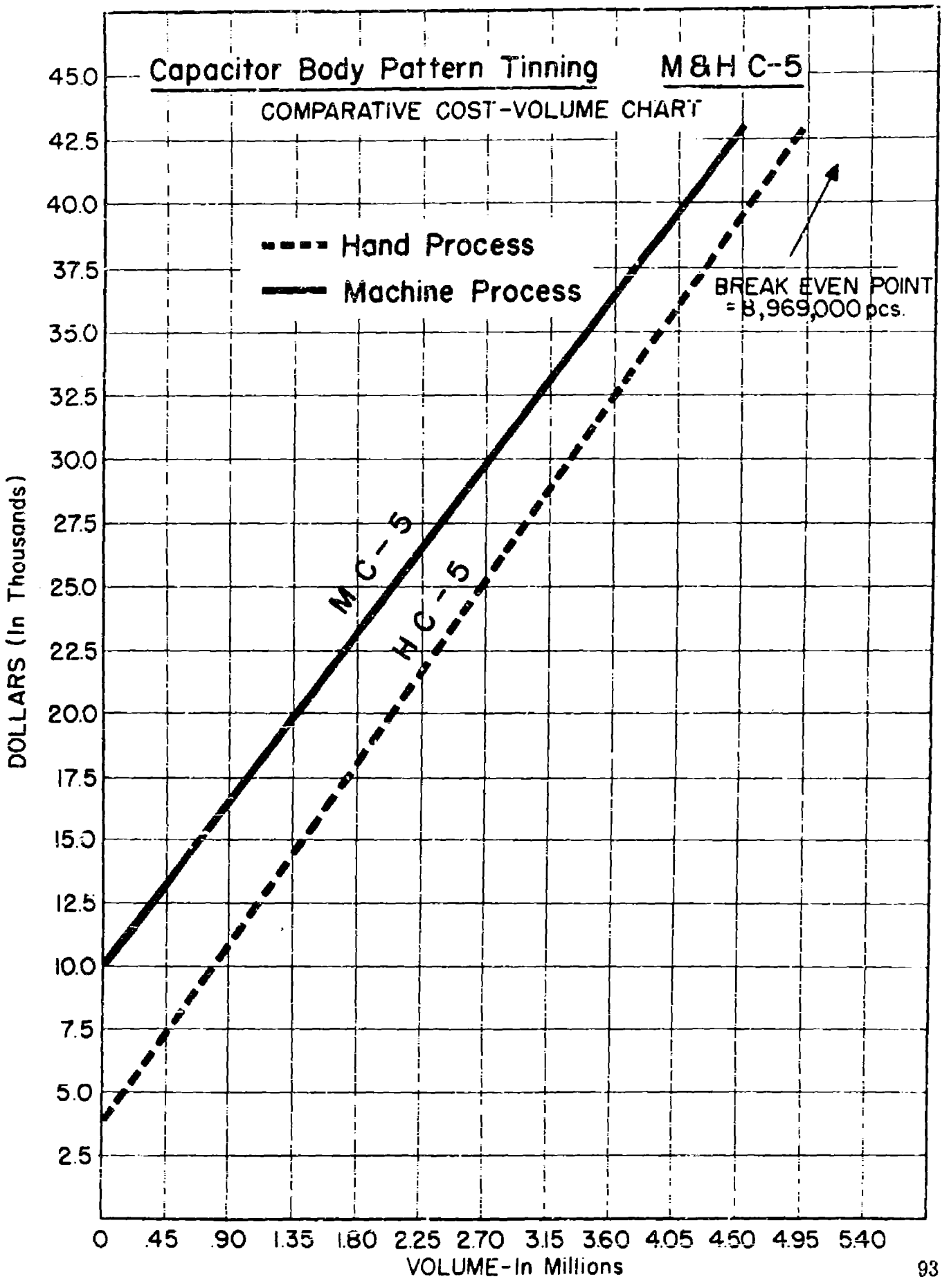
Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 and annual prod. 5,440,000 (B)

		Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 21,524 (C) x Rate 1.6 =	$34,468.00	xx	$34,468.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 34,468.	10,340.40	$3,102.12	7,238.28
b. Mach., Equip. & Tool	187.60	152.43	35.17
c. Occupancy = Proc. Space 150 (D) x Ratio 5 = 750 sq. ft.			
Rent 750 x .8 =	600.00	600.00	----
Light 750 x .3 =	225.00	22.50	202.50
Heat 750 x .1 =	75.00	56.25	18.75
Subtotal - a, b, and c	$11,428.00		
d. Miscellaneous = 10% x Subtotal 11,428 =	1,142.80		1,142.80
Total - a, b, c, and d	12,570.80	3,933.30	8,637.50
GRAND TOTALS	$47,038.80	$3,933.30	$43,105.50

Notes:

(A) Equipment for 5 stations = $938
(B) 34 x 40 = 1,360 hrly. prod. x 4,000 = 5,440,000
(C) 5.38560 x 4,000 = 21,542
(D) 5 stations x 30 sq. ft. = 150 sq. ft.

Cost per piece = $\frac{\$47,038.80}{5,440,000} = .00866$


Capacitor Body Pattern Tinning
M&H C-5
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
BREAK EVEN POINT
= 8,969,000 pcs.
MC-5
HC-5
DOLLARS (In Thousands)
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
.45
.90
1.35
1.80
2.25
2.70
3.15
3.60
4.05
4.50
4.95
5.40
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body to Wafer Assembly Mach. No. MC-6

Equipment 3 Capacitor Assemblers (A)

Based on 2 shifts, 3,923 hrs., hourly prod. 702 and annual prod. 2,754,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 9.60 (B) =	$38,400	xx	$38,400
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. $38,000 =	11,520	$ 3,456	8,064
b. Mach., Equip. & Tool	33,237	17,467	15,770
c. Occupancy = Proc. Space 264 x Ratio 6 = 1,584 sq. ft.			
Rent 1584 x 1.00 =	1,584	1,584	---
Light 1584 x .30 =	475	48	427
Heat 1584 x .10 =	158	120	38
Subtotal - a, b, and c	$46,974	$22,675	$24,299
d. Miscellaneous = 10% x Subtotal 46,074 =	4,697	2,268	2,429
Total - a, b, c, and d	51,671	24,943	26,728
GRAND TOTALS	$90,071	$24,943	$65,128

Notes:

(A) 3 Assemblers @ $27,000 = $82,500
(B) 6 Semi-skilled @ $1.60 = $9.60

Cost per piece = $\frac{\$90,071}{2,754,000} = .0327$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Assem. Capacitor Body to Wafer, Assem. Leads, Subassem. Cap., and Apply Protective Coating — Hand — No. HC-6, 6a, 6b, 6c

Based on 2 shifts, 4,000 hours and annual production 2,880,000 wafers

	Total	Fixed	Variable
HC-6	$50,136.08	$4,275.72	$45,860.36
HC-6a	86,203.49	7,126.95	79,076.54
HC-6b	17,060.54	1,454.98	15,605.56
HC-6c	82,801.72	6,875.95	75,925.77
GRAND TOTALS	$236,201.83	$19,733.60	$216,468.23

Notes: Cost per piece = $\frac{\$236,201.83}{2,880,000 \text{ wafers}} = .082$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Body to Wafer Assembly Hand No. HC-6

Equipment (A)

Based on 2 shifts, 4,000 hrs., hourly prod. (B) 760 and annual prod. (B) 3,040,000

	Total	Annual Costs Fixed	Variable
1. Material		xx	
2. Direct Labor = (C) 22,897 x Rate 1.6 =	$36,636.16	xx	$36,636.16
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 36,636.16 =	10,990.85	$3,297.26	7,693.59
b. Mach., Equip. & Tool	201.80	163.96	37.84
c. Occupancy =			
Proc. Space (D) 180 x Ratio 5 = 900 sq. ft.			
Rent 900 x .8 =	720.00	720.00	---
Light 900 x .3 =	270.00	27.00	243.00
Heat 900 x .1 =	90.00	67.50	22.50
Subtotal - a, b, and c	12,272.65		
d. Miscellaneous =			
10% x Subtotal 12,272.65 =	1,227.27		1,227.27
Total - a, b, c, and d	13,499.92		
GRAND TOTALS	$50,136.08	$4,275.72	$45,860.36

Notes:

(A) Solder pots, cleaning and rinsing pots, tweezers, bench and stool; cost for 6 stations = $1,008.70

(B) 4 (.02 & .01) cap's x 40 = 160 pcs/hr x 4,000 = 640,000
8 (two .01) " x 40 = 320 " x 4,000 = 1,280,000
7 (one .01) " x 40 = 280 " x 4,000 = 1,120,000
760 3,040,000 annual prod.

(C) 2.112 (men/hr to make 40 mod/hr) x 4,000 hrs = 8,448.00 dir. lab. hrs.
2.288 (") x 4,000 = 9,152.00 "
1.3244 (") x 4,000 = 5,297.60 "
22,897.60

(D) Based on 30 sq. ft. x 6 stations = 180 sq. ft.

Cost per piece = $\frac{\$50,136.08}{3,040,000}$ = .0165

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Assemble Capacitor Leads Hand No. HC-6a

Equipment (A)

Based on 2 shifts, 4,000 hrs., hrly. prod. (B) 880 and annual prod. (B) 3,520,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = hrs. (C) 39,529.6 x Rate 1.6	$63,247.36	xx	$63,247.36
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 63,247.36 =	18,974.21	$5,692.26	13,281.95
b. Mach., Equip. & Tool	95.00	77.19	17.81
c. Occupancy =			
Proc. Space (D) 300 x Ratio 5 = 1,500 sq. ft.			
Rent 1500 x .8 =	1,200.00	1,200.00	----
Light 1500 x .3 =	450.00	45.00	405.00
Heat 1500 x .1 =	150.00	112.50	37.50
Subtotal - a, b, and c	$20,869.21		
d. Miscellaneous =			
10% x Subtotal 20,869.21 =	2,086.92		2,086.92
Total - a, b, c, and d	22,956.13		
GRAND TOTALS	$86,203.49	$7,126.95	$79,076.54

Notes:

(A) Hand soldering iron, bench, stool; cost for 10 stations = $474.93

(B) 10 ops one side x 40 ops/hr = 400 x 4,000 hrs = 1,600,000
12 ops two sides x 40 " = 480 x 4,000 hrs = 1,920,000
880 3,520,000 pcs annual prod

(C) 3.124 (men/hr to make 40 mod/hr) x 4,000 = 12,496.00 dir lab hrs (1 side)
6.7584 (") x 4,000 = 27,033.60 " (2 sides)
39,529.60 "

(D) Based on 30 sq. ft. x 10 stations = 300 sq. ft.

Cost per piece = $\frac{\$86,203.49}{3,520,000} = .0245$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Subassemble Capacitors Hand No. HC-6b

Equipment (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 200 and annual prod. 800,000 (B)

	Total	Annual Costs Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 7,792 (C) x Rate 1.6 =	$12,467.20	xx	$12,467.20
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 12,467.20 =	3,740.16	$1,122.05	2,618.11
b. Mach., Equip., & Tool	75.60	61.43	14.17
c. Occupancy = Proc. Space 60 (D) x Ratio 5 = 300 sq. ft.			
Rent 300 x .8 =	240.00	240.00	----
Light 300 x .3 =	90.00	9.00	81.00
Heat 300 x .1 =	30.00	22.50	7.50
Subtotal - a, b, and c	$ 4,175.76		
d. Miscellaneous = 10% x Subtotal 4,175.76 =	417.58		417.58
Total - a, b, c, and d	4,593.34		
GRAND TOTALS	$17,060.54	$1,454.98	$15,605.56

Notes:

(A) Solder pot, cleaning & rinsing pot, overhead exhaust, bench, stool (cost for 2 stations = $378)

(B) 5 x 40 = 200 hrly. prod., 200 x 4,000 = 800,000 annual prod.

(C) 1.9480 x 4,000 = 7,792 dir. lab. hrs.

(D) 2 stations x 30 sq. ft. = 60 sq. ft.

$$\text{Cost per piece} = \frac{\$17,060.54}{800,000 \text{ pcs}} = .0213$$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Apply Protective Coating Hand No. HC-6c

Equipment (A)

Based on 2 shifts, 4,000 hrs., hrly. prod. (B) 720 and annual prod. (B) 2,880,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Dir. Lab. = hrs. (C) 37,945.6 x Rate 1.6 =	$60,712.96	xx	$60,712.96
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 60,712.96 =	18,213.89	$5,464.17	12,749.72
b. Mach., Equip. & Tool	66.80	54.28	12.52
c. Occupancy =			
Proc. Space (D) 300 x Ratio 5 = 1,500 sq. ft.			
Rent 1,500 x .8 =	1,200.00	1,200.00	---
Light 1,500 x .3 =	450.00	45.00	405.00
Heat 1,500 x .1 =	150.00	112.50	37.50
Subtotal - a, b, and c	20,080.69		
d. Miscellaneous =			
10% x Subtotal 20,080.69 =	2,008.07		2,008.07
Total - a, b, c, and d	22,088.76		
GRAND TOTALS	$82,801.72	$6,875.95	$75,925.77

Notes:

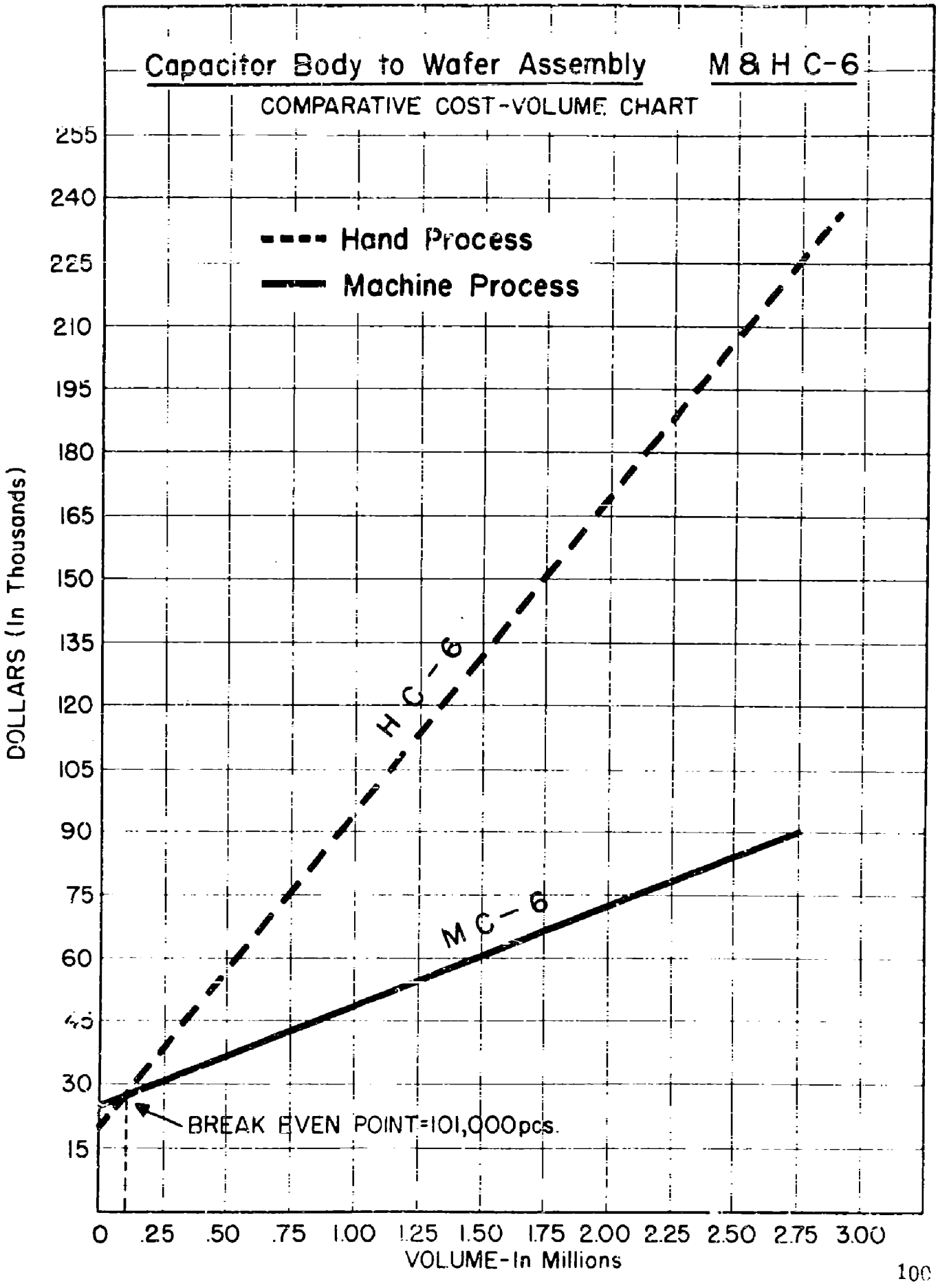
(A) Bench, stool, artists brushes, hysol containers; cost for 10 sta. = $334.40

(B) 8 ops on one side x 40 = 320 pcs/hr x 4,000 = 1,280,000
10 ops on two sides x 40 = 400 pcs/hr x 4,000 = 1,600,000
720 pcs/hr 2,880,000

(C) 2.7104 (men/hr to make 40 mod/hr) x 4,000 hrs. = 10,841.6 Dir. Lab. Hrs.
6.776 (") x 4,000 hrs. = 27,104.0 "
37,945.6

(D) Based on 30 sq. ft/sta , x 10 stations = 300 sq. ft.

Cost per piece = $\frac{\$82,801.72}{2,880,000} = .0288$


Capacitor Body to Wafer Assembly
M & H C-6
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
H C-6
M C-6
BREAK EVEN POINT=101,000pcs.
DOLLARS (In Thousands)
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
.25
.50
.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Wafer Assembly Notch Solder Filling Mach. No. MC-7

Equipment 2-Notch Tinners (A)

Based on 2 shifts, 3,375 hrs., hourly prod. 816 and annual prod. 2,754,000

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 2.40 (B) =	$9,600	xx	$9,600
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 9,600 =	2,880	$ 864	2,016
b. Mach., Equip. & Tool	4,767	2,435	2,332
c. Occupancy = Proc. Space 60 x Ratio 6 = 360 sq. ft.			
Rent 360 x 1.00 =	360	360	---
Light 360 x .30 =	108	11	97
Heat 360 x .10 =	36	27	9
Subtotal - a, b, and c	8,151	3,697	4,454
d. Miscellaneous = 10% x Subtotal 8,151 =	815	370	445
Total - a, b, c, and d	8,966	4,067	4,899
GRAND TOTALS	$18,566	$4,067	$14,499

Notes: (A) 2 Notch Tinners @ $5,700 = $11,500.
(B) 2 Unskilled @ $1.20 = $2.40

Cost per piece = $\frac{\$18,566}{2,754,000} = .00674$

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Capacitor Wafer Assembly Notch Solder Filling Hand No. HC-7

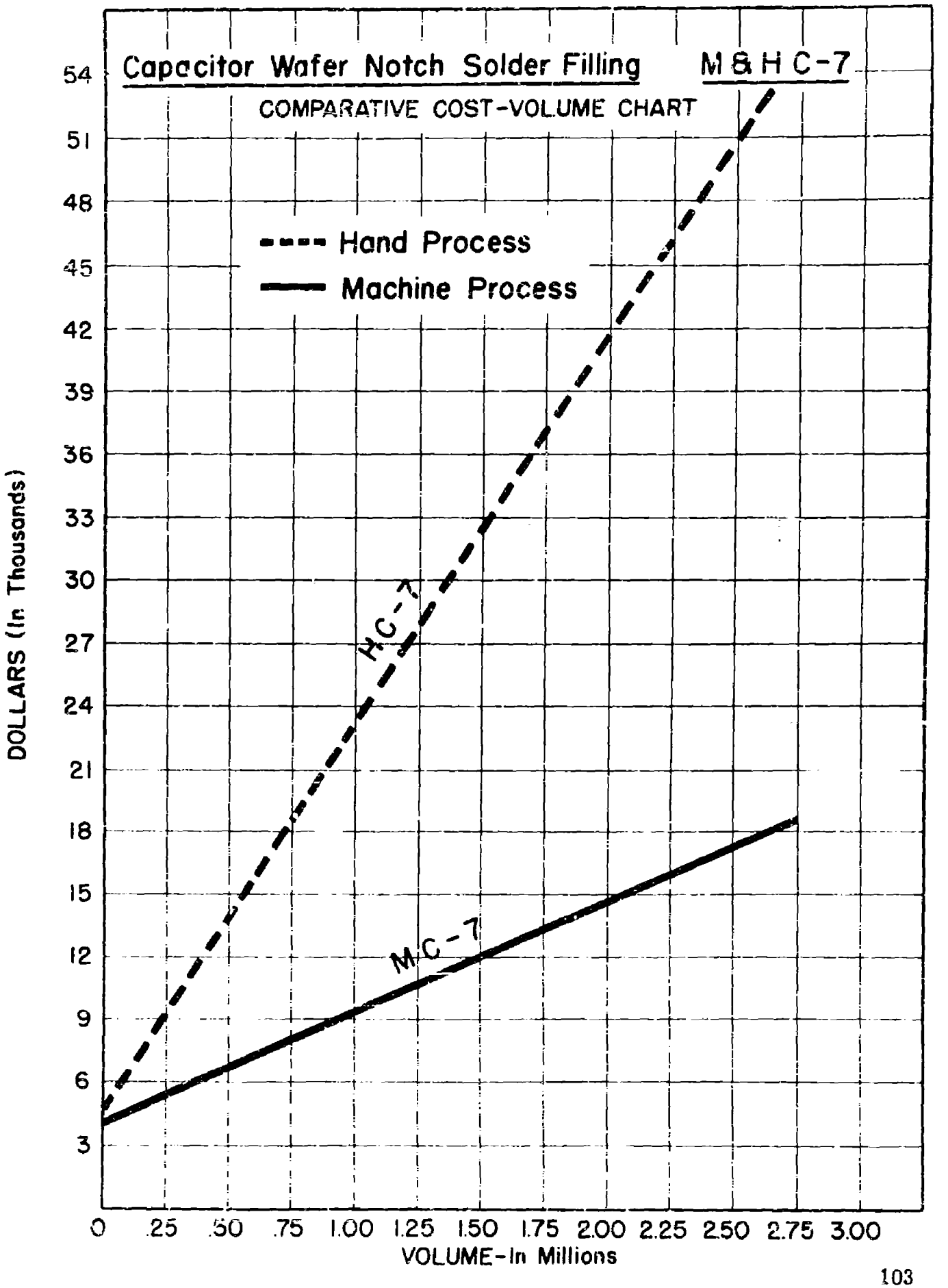
Equipment Benches, stools, soldering irons, and fixtures (A)

Based on 2 shifts, 4000 hrs., hourly prod. 720 and annual prod. 2,880,000 (B)

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 25,344.00 (C) x Rate 1.6 =	$40,550.40	xx	$40,550.40
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 40,550.40 =	12,165.12	$3,649.54	8,515.58
b. Mach., Equip. & Tool	63.00	51.19	11.81
c. Occupancy = Proc. Space 180(D) x Ratio 5 = 900 sq. ft.			
Rent 900 x .8 =	720.00	720.00	
Light 900 x .3 =	270.00	27.00	243.00
Heat 900 x .1 =	90.00	67.50	22.50
Subtotal - a, b, and c	13,308.12		
d. Miscellaneous = 10% x Subtotal 13,308.12 =	1,330.81		1,330.81
Total - a, b, c, and d	14,638.93		
GRAND TOTALS	$55,189.33	$4,515.23	$50,674.10

Notes:

Cost per piece = $\frac{\$55,189.33}{2,880,000} = .0197$


Capacitor Wafer Notch Solder Filling
M & H C-7
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HC-7
MC-7
DOLLARS (In Thousands)
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
.25
.50
.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Wafer Assembly Inspection Mach. No. MC-8

Equipment 2 Capacitor Assembly Testers (A)

Based on 2 shifts, 2,822 hrs., hourly prod. 976 and annual prod. 2,754,000

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3,440 x Rate 4.80 (B) =	$16,512	xx	$16,512
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 16,512 =	4,954	$1,486	3,468
b. Mach., Equip. & Tool	9,627	5,081	4,546
c. Occupancy = Proc. Space 92 x Ratio 6 = 552 sq. ft.			
Rent 552 x 1.00 =	552	552	---
Light 552 x .30 =	166	17	149
Heat 552 x .10 =	55	42	13
Subtotal - a, b, and c	$15,354	$7,178	$ 8,176
d. Miscellaneous = 10% x Subtotal 15,354 =	1,535	718	817
Total - a, b, c, and d	16,889	7,896	8,993
GRAND TOTALS	$33,401	$7,896	$25,505

Notes: (A) 2 Testers @ $12,000 = $24,000
(B) 2 Highly Skilled @ $2.40 = $4.80

Cost per piece = $\frac{\$33,401}{2,754,000} = .0121$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Capacitor Wafer Assembly Inspection Hand No. HC-8

Equipment Benches, stools & electrical testers (A)

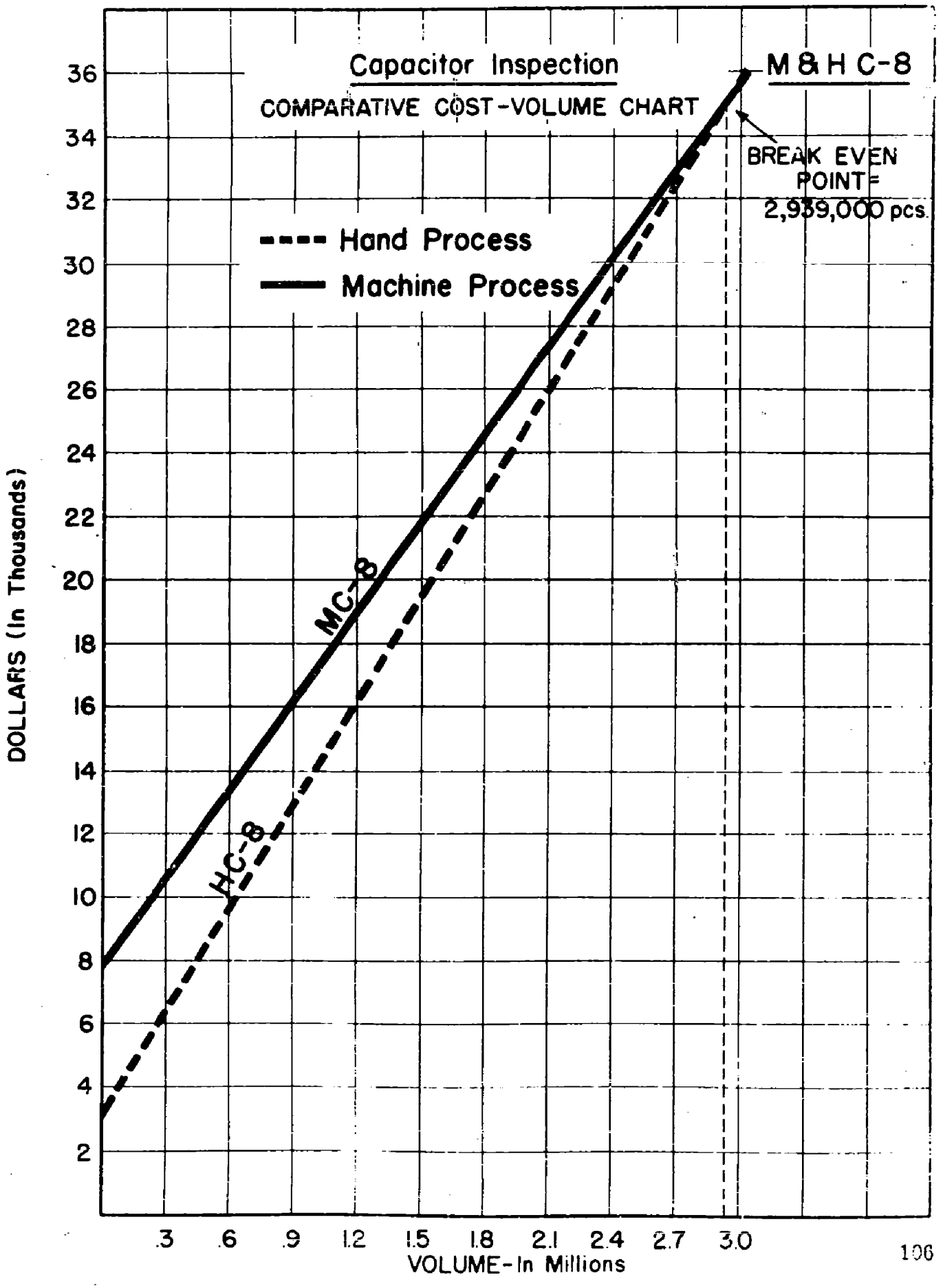
Based on 2 shifts, 4,000 hrs., hourly prod. 1,360 ops. and annual prod. 2,880,000 wafers

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 15,558.4 (B) x Rate 1.6 =	$24,893.44	xx	$24,893.44
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 24,893.44 =	7,668.03	$2,300.41	5,367.62
b. Mach., Equip. & Tool	432.00	351.00	81.00
c. Occupancy =			
Proc. Space 120 (C) x Ratio 5 = 600 sq. ft.			
Heat 600 x .8 =	480.00	480.00	----
Light 600 x .3 =	180.00	18.00	162.00
Heat 600 x .1 =	60.00	45.00	15.00
Subtotal a, b, and c	$ 8,820.03		
d. Miscellaneous =			
10% x Subtotal 8,820.03 =	882.00	---	882.00
Total - a, b, c, and d	9,702.03		
GRAND TOTALS	$34,595.47	$3,194.41	$31,401.06

Notes.

(A) Cost for 4 stations = $2,160
(B) 3.88960 x 4,000 = 15,558.40 Dir. Lab. Hrs.
(C) 4 stations x 30 sq. ft. = 120

Cost per wafer = $\frac{\$34,595.47}{2,880,000} = .0120$


Capacitor Inspection
COMPARATIVE COST-VOLUME CHART
M & H C-8
BREAK EVEN POINT = 2,939,000 pcs.
Hand Process
Machine Process
MC-8
HC-8
DOLLARS (In Thousands)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
.3
.6
.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Tube Socket Wafer Pattern Tinning Mach. No. MTS-1

Equipment (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 1,296 and annual prod. 1,794,000 (B)

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 4.80 =	$19,200.00	xx	$19,200.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 19,200 =	5,760.00	$1,728.00	4,032.00
b. Mach., Equip. & Tool	3,732.00	3,420.00	312.00
c. Occupancy = Proc. Space 66 x Ratio 6 = 396 sq. ft.			
Rent 396 x 1.00 =	396.00	396.00	
Light 396 x .30 =	119.00	12.00	107.00
Heat 396 x .10 =	40.00	30.00	10.00
Subtotal - a, b, and c	$10,047.00	$5,586.00	$ 4,461.00
d. Miscellaneous = 10% x Subtotal 10,047.00 =	1,005.00	559.00	446.00
Total - a, b, c, and d	11,052.00	6,145.00	4,907.00
GRAND TOTALS	$30,252.00	$6,145.00	$24,107.00

Notes: (A) Operation accomplished on pattern tinner used also for capacitor wafers (see C-1).

(B) Annual production of wafers as follows:

Capacitor wafers =	3,390,000
Tube socket wafers =	1,794,000
	5,184,000

Cost per piece = $\frac{\$30,252}{5,184,000}$ = .00584

An individual comparative cost-volume chart has not been prepared for MTS-1 and HTS-1 because of the combination of capacitor and tube socket wafer processing in the machine process manufacture. A combined chart has been prepared as Schedule 8c for MC-1 and MTS-1 vs. HC-1 and HTS-1.

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Tube Socket Wafer Pattern Tinning Hand No. HTS-1

Equipment (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 720 and annual prod. 1,440,000 (B)

	Total	Annual Costs Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 8,481.60 (C) x Rate 1.6 =	$13,570.56	xx	$13,570.56
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 13,570.56 =	4,071.17	$1,221.35	2,849.82
b. Mach., Equip. & Tool	75.00	60.94	14.06
c. Occupancy = Proc. Space 60 (D) x Ratio 5 x 300 sq. ft.			
Rent 300 x .8 =	240.00	240.00	
Light 300 x .3 =	90.00	9.00	81.00
Heat 300 x .1 =	30.00	22.50	7.50
Subtotal - a, b, and c	4,506.17		
d. Miscellaneous = 10% x Subtotal 4,506.17	450.62		450.62
Total - a, b, c, and d	4,956.79		
GRAND TOTALS	$18,527.35	$1,553.79	$16,973.56

Notes: (A) Same as HC-1 but 2 stations, cost = $375.
(B) 9 ops. x 40 = 360 x 4000 = 1,440,000 annual production
(C) 2.12040 x 4000 = 8,481.60 Direct Labor Hrs.
(D) 2 stations x 30 sq. ft. = 60

Cost per piece = $\frac{\$18,527.35}{1,440,000} = .0129$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Tube Socket Parts to Wafer Assembly Mach. No. MTS-2

Equipment 3-Tube Socket Assemblers (A)

Based on 2 shifts, 3,115 hrs., hourly prod. 468 and annual prod. 1,458,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 3,720 x Rate 7.20 (B) =	$26,784	xx	$26,784
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 26,784 =	8,035	$ 2,411	5,624
b. Mach., Equip. & Tool	38,475	20,325	18,150
c. Occupancy = Proc. Space 180 x Ratio 6 = 1,080 sq. ft.			
Rent 1080 x 1.00 =	1,080	1,080	---
Light 1080 x .30 =	324	32	292
Heat 1080 x .10 =	108	81	27
Subtotal - a, b, and c	$48,022	$23,929	$24,093
d. Miscellaneous = 10% x Subtotal 48,022 =	4,802	2,393	2,409
Total - a, b, c, and d	52,824	26,322	26,502
GRAND TOTALS	$79,608	$26,322	$53,286

Notes:

(A) 3-Tube Socket Assemblers @ $32,000 = $96,000

(B) 2-Skilled @ $2.00 = $4.00
2-Semi-skilled @ $1.60 = 3.20
$7.20

Cost per piece = $\frac{\$79,608}{1,458,000} = .0546$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Tube Socket Parts-to-Wafer Assembly Hand No. HTS-2

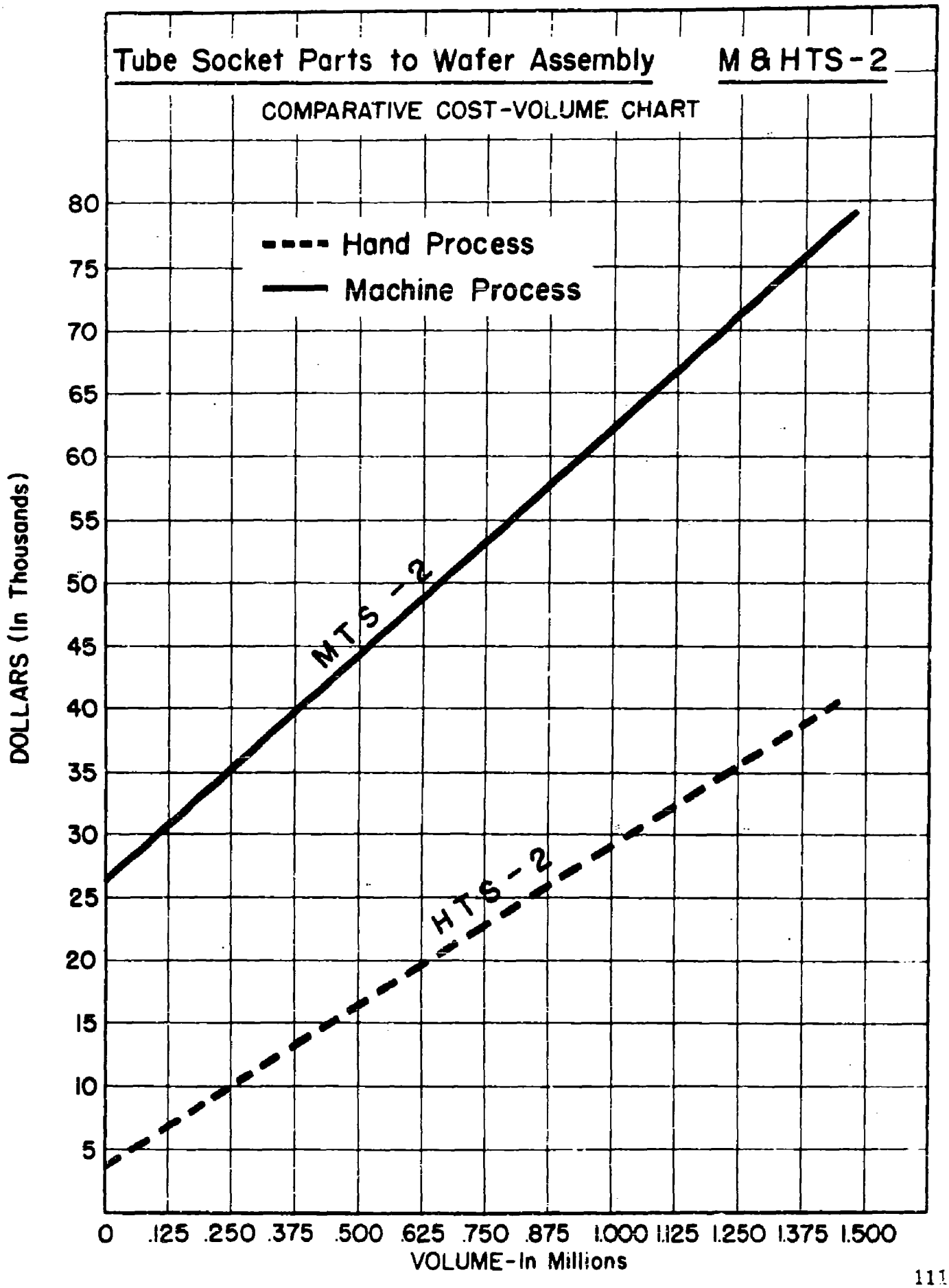
Equipment Benches, stools, eyeletting mach. and spec. fixtures (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 360 and annual prod. 1,440,000 (B)

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 18,374.40 (C) x Rate 1.6 =	$29,399.04	xx	$29,399.04
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 29,399.04 =	8,819.71	$2,645.91	6,173.80
b. Mach., Equip. & Tool	270.60	219.86	50.74
c. Occupancy =			
Proc. Space 150 (D) x Ratio 5 = 750 sq. ft.			
Rent 750 x .8 =	600.00	600.00	---
Light 750 x .3 =	225.00	22.50	202.50
Heat 750 x .1 =	75.00	56.25	18.75
Subtotal - a, b, and c	9,990.31		
d. Miscellaneous =			
10% x Subtotal 9,990.31 =	999.03		999.03
Total - a, b, c, and d	10,989.34		
GRAND TOTALS	$40,388.38	$3,544.52	$36,843.86

Notes: (A) Equipment for 5 stations = $1,353.
(B) 9 ops x 40 = 360 per hr. x 4,000 = 1,440,000 annual prod.
(C) 4.59360 x 4,000 = 18,374.40 Dir. Lab. Hrs.
(D) 5 stations x 30 = 150

Cost per piece = $\frac{\$40,388.38}{1,440,000} = .028$


Tube Socket Parts to Wafer Assembly
M & HTS-2
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
MTS-2
HTS-2
DOLLARS (In Thousands)
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
.125
.250
.375
.500
.625
.750
.875
1.000
1.125
1.250
1.375
1.500
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Tube Socket Notch Solder Filling Mach. No. MTS-3

Equipment 1 Notch Tinner (A)

Based on 2 shifts, 3,574 hrs., hourly prod. 408 and annual prod. 1,458,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 1.20 =	$4,800	xx	$4,800
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 4,800 =	1,440	$ 432	1,008
b. Mach., Equip. & Tool	2,380	1,218	1,162
c. Occupancy =			
Proc. Space 25 x Ratio 5 = 150 sq. ft.			
Rent 150 x 1.00 =	150	150	
Light 150 x .30 =	45	5	40
Heat 150 x .10 =	15	12	3
Subtotal - a, b, and c	$4,030	$1,817	$2,213
d. Miscellaneous =			
10% x Subtotal 4,030 =	403	182	221
Total - a, b, c, and d	4,433	1,999	2,434
GRAND TOTALS	$9,233	$1,999	$7,234

Notes:

(A) 1 Notch Tinner @ $5,750
(B) 1 Unskilled @ $1.20

Cost per piece = $\frac{\$9,233}{1,458,000}$ = .0063

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Tube Socket Notch-to-Connector Soldering Hand No. HTS-3

Equipment Benches, stools, solder pots, tweezers, overhead hood (A)

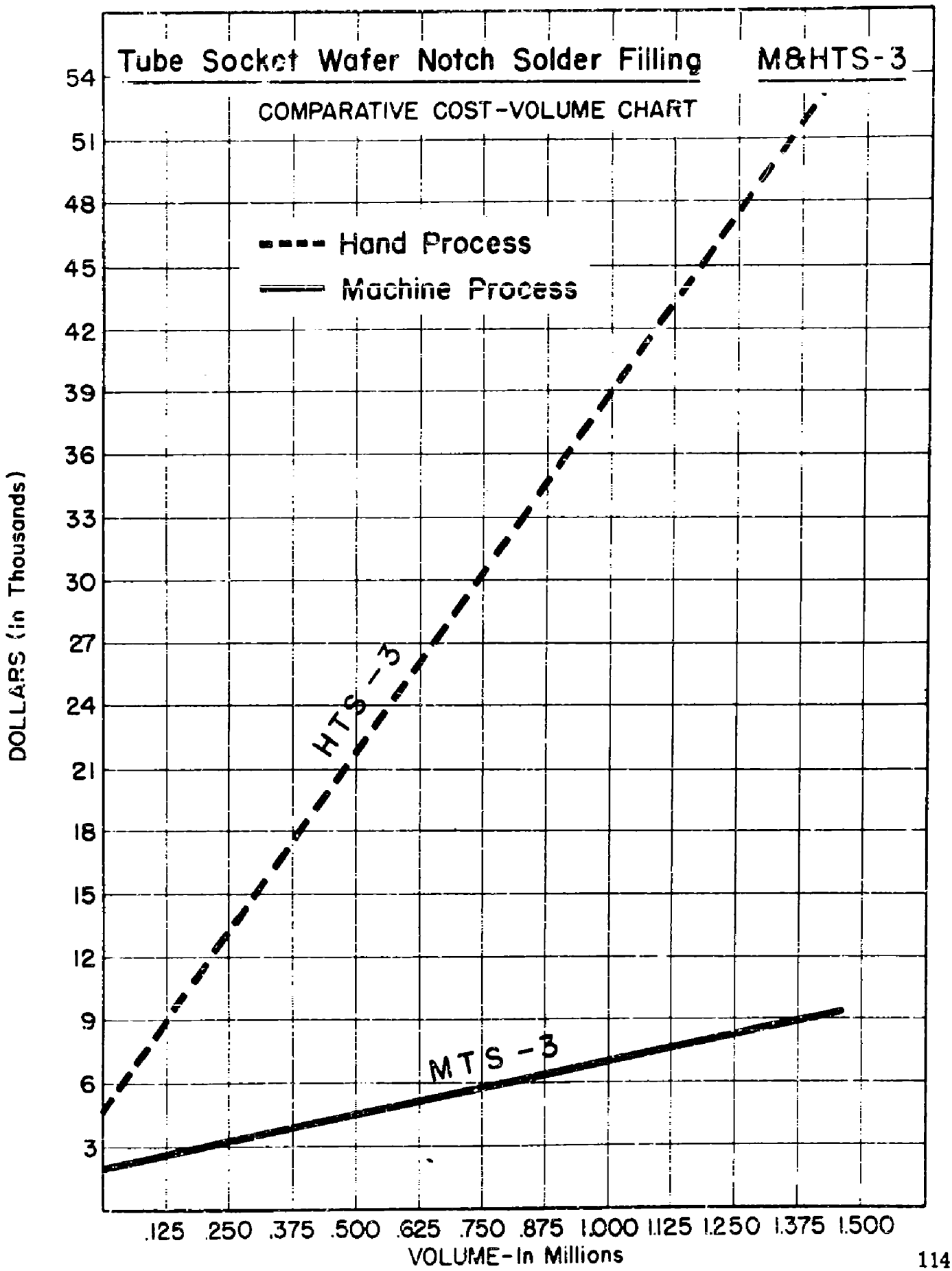
Based on 2 shifts, 4,000 hrs., hourly prod. 360 and annual prod. 1,440,000 (B)

		Annual Cost	
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 24,710.40 (C) x Rate 1.6 =	$39,536.64	xx	$39,536.64
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 39,536.64 =	11,860.99	$3,558.30	8,302.69
b. Mach., Equip. & Tool	279.20	226.85	52.35
c. Occupancy = Proc. Space 180 x Ratio 5 = 900 sq.ft.			
Rent 900 x .8 =	720.00	720.00	----
Light 900 x .3 =	270.00	27.00	243.00
Heat 900 x .1 =	90.00	67.50	22.50
Subtotal - a, b, and c	$13,220.19		
d. Miscellaneous = 10% x Subtotal 13,220.19 =	1,322.02		1,322.02
GRAND TOTALS	$54,078.85	$4,599.65	$49,479.20

Notes:

(A) Equipment for 6 stations = $1,396
(B) 9 ops x 40 = 360 per hr. x 4,000
(C) 6.17760 x 4,000 = 24,710.40 Dir. Lab. Hrs.
(D) 6 stations x 30 sq. ft. = 180

Cost per piece = $\frac{\$54,078.85}{1,440,000} = .0375$


Tube Socket Wafer Notch Solder Filling
M&HTS-3
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HTS-3
MTS-3
DOLLARS (in Thousands)
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
.125 .250 .375 .500 .625 .750 .875 1.000 1.125 1.250 1.375 1.500
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Elect. Inspection of Tube Sockets Hand No. HTS-4

Equipment Benches, stools and meters (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 360 and annual prod. 1,440,000 (B)

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 7,545.60 (C) x Rate 1.6 =	$12,072.96	xx	$12,072.96
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 12,072.96	3,621.89	$1,086.57	2,535.32
b. Mach., Equip. & Tool	71.60	58.18	13.42
c. Occupancy = Proc. Space 60 (D) x Ratio 5 = 300 sq. ft.			
Rent 300 x .8 =	240.00	240.00	----
Light 300 x .3 =	90.00	9.00	81.00
Heat 300 x .1 =	30.00	22.50	7.50
Subtotal - a, b, and c	$ 4,053.49		
d. Miscellaneous = 10% x Subtotal 4,053.49 =	405.35		405.35
Total - a, b, c, and d	4,458.84		
GRAND TOTALS	$16,531.80	$1,416.25	$15,115.55

Notes:

(A) Equipment for 2 stations @ $358.
(B) 9 opers x 40 = 360 x 4,000
(C) 1.88640 x 4,000 = 7,545.60 Dir. Lab. Hrs.
(D) 2 stations x 30 = 60 sq. ft.

Cost per piece = $\frac{\$16,531.80}{1,440,000}$ = .0115

This operation is not performed in present machine process manufacture, and therefore the cost is not charged against the projected hand process.

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Module Assembly Mach. No. MM-1

Equipment 5 Module Assemblers (A)

Based on 2 shifts, 3,471 hrs., hourly prod. 420 and annual prod. 1,458,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 16.00 (B) =	$ 64,000	xx	$ 64,000
3. Manufacturing Overhead			
a. Indirect Labor = 30% of Dir. 64,000 =	19,197	$ 5,757	13,440
b. Mach., Equip. & Tool	62,924	33,342	29,582
c. Occupancy =			
Proc. Space 590 x Ratio 6 = 3,540 sq. ft.			
Rent 3540 x 1.00 =	3,540	3,540	---
Light 3540 x .30 =	1,061	104	957
Heat 3540 x .10 =	356	260	96
Subtotal - a, b, and c	$ 87,078	$43,003	$ 44,075
d. Miscellaneous = 10% x Subtotal 87,078 =	8,708	4,300	4,408
Total - a, b, c, and d	95,786	47,303	48,483
GRAND TOTALS	$159,786	$47,303	$112,483

Notes:

(A) 5 Module Assemblers @ $31,500 = $157,500
(B) 10 Semi-skilled @ 1.60 = $16.00

Cost per piece = $\frac{\$159,786}{1,458,000} = .1096$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Module Assembly Hand No. HM-1

Equipment Benches, stools and assembly fixtures

Based on 2 shifts, 4,000 hrs., hourly prod. 400 and annual prod. 1,600,000 (B)

		Annual Cost		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 67,760.0 x Rate 1.6 =	$108,416.00	xx	$108,416.00
3. Manufacturing Overhead			
a. Ind. Lab. - 30% of Dir. 108,416.00 =	32,524.80	$ 9,757.44	22,767.36
b. Mach., Equip. & Tool	5,273.10	3,295.69	1,977.41
c. Occupancy = Proc. Space 510 (D) x Ratio 5 = 2,550 sq. ft.			
Rent 2550 x .8 =	2,040.00	2,040.00	---
Light 2550 x .3 =	765.00	76.50	688.50
Heat 2550 x .1 =	255.00	191.25	63.75
Subtotal - a, b, and c	$ 40,857.90		
d. Miscellaneous = 10% x Subtotal 40,857.90 =	4,085.79		4,085.79
Total - a, b, c, and d	44,943.69		
GRAND TOTALS	$153,359.69	$15,360.88	$137,998.81

Notes:

(A) Cost for 17 stations = $17,577
(B) 10 opers x 40 = 400 x 4,000 = 1,600,000 annual prod.
(C) 16.940 x 4,000 = 67,760
(D) 17 stations x 30 sq. ft. = 510

Cost per piece $\frac{\$153,359.69}{1,600,000} = .0958$

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Inspect. & Resoldering of Module Assembly Hand No. HM-1a

Equipment Benches, stools & soldering irons (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 400 and annual prod. 1,600,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 27,984.00 (B) x Rate 1.6 =	$44,744.40	xx	$44,744.40
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 44,744.40 =	13,432.32	$4,029.70	9,402.62
b. Mach., Equip. & Tool	74.60	60.61	13.99
c. Occupancy = Proc. Space 210 (C) x Ratio 5 = 1,050 sq.ft.			
Rent 1050 x .8 =	840.00	840.00	---
Light 1050 x .3 =	315.00	31.50	283.50
Heat 1050 x .1 =	105.00	78.75	26.25
Subtotal - a, b, and c	$14,766.92		
d. Miscellaneous = 10% x Subtotal 14,766.92 =	1,476.69		1,476.69
Total - a, b, c, and d	16,243.61		
GRAND TOTALS	$60,988.01	$5,040.56	$55,947.45

Notes:

(A) Cost of equipment for 7 stations = $373
(B) 6.996 x 4,000 = 27,984
(C) 7 stations x 30 sq. ft. = 210 sq. ft.

Cost per piece = $\frac{\$60,988.01}{1,600,000} = .0381$

This is essentially a salvaging operation which is not being performed in the present machine process manufacture and therefore is not being charged against the projected hand process manufacture.

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Straighten Module Wire-ends Hand No. HM-1b

Equipment Benches, stools & straightening jigs (A)

Based on 2 shifts, 4,000 hrs., hourly prod. 400 and annual prod. 1,600,000 (B)

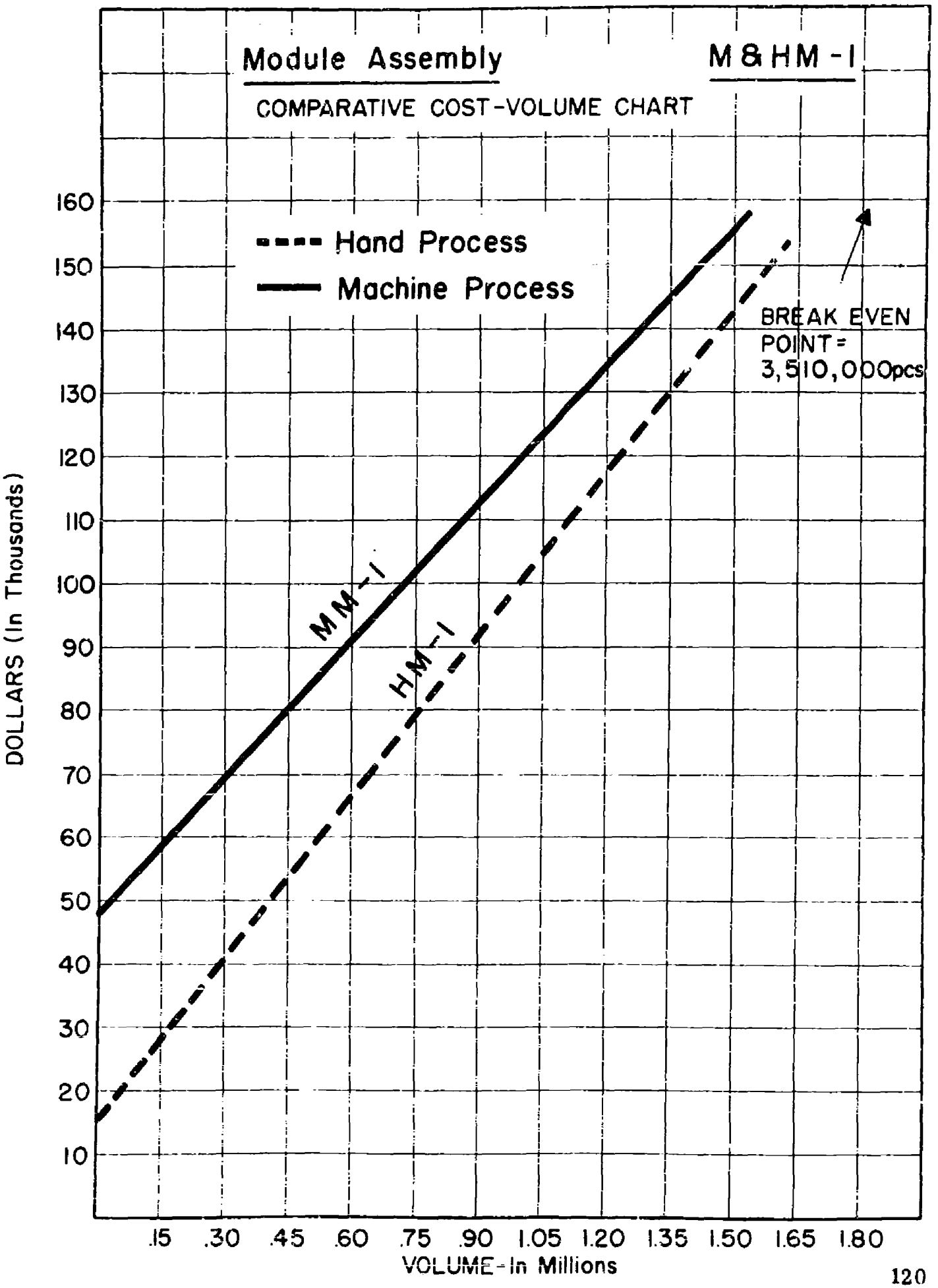
	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 14,080.00 (C) x Rate 1.6 =	$22,528.00	xx	$22,528.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 22,528.00 =	6,758.40	$2,027.52	4,730.88
b. Mach., Equip. & Tool	40.00	32.50	7.50
c. Occupancy = Proc. Space 120 (D) x Ratio 5 = 600 sq. ft.			
Rent 600 x .8 =	480.00	480.00	---
Light 600 x .3 =	180.00	18.00	162.00
Heat 600 x .1 =	60.00	15.00	45.00
Subtotal - a, b, and c	$ 7,518.40		
d. Miscellaneous = 10% x Subtotal 7,518.40 =	751.84		751.84
Total - a, b, c, and d	8,270.24		
GRAND TOTALS	$30,798.24	$2,573.02	$28,225.22

Notes:

(A) Cost of equipment for 4 stations = $200
(B) 10 ops x 40 = 400 x 4,000 = 1,600,000 annual prod.
(C) 3.52 x 4,000 = 14,080
(D) 4 stations x 30 sq. ft. = 120

Cost per piece = $\frac{\$30,798.24}{1,600,000} = .0192$

This operation is not being performed in the present machine process manufacture, and therefore is not being charged against the projected hand process manufacture.


Module Assembly
M & HM - I
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
BREAK EVEN POINT = 3,510,000pcs
MM-I
HM-I
DOLLARS (In Thousands)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
.15
.30
.45
.60
.75
.90
1.05
1.20
1.35
1.50
1.65
1.80
VOLUME - In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Module Riser Wire Clipping Mach. No. MM-2

Equipment 2 Segment Clippers (A)

Based on 2 shifts, 3,797 hrs., hourly prod. 384 and annual prod. 1,458,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,000 x Rate 3.20 (B) =	$12,800	xx	$12,800
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 12,800 =	3,840	$1,152	2,688
b. Mach., Equip. & Tool	11,600	6,140	5,460
c. Occupancy =			
Proc. Space 122 x Ratio 6 = 732 sq. ft			
Rent 732 x 1.00 =	732	732	------
Light 732 x .30 =	220	22	198
Heat 732 x .10 =	73	54	19
Subtotal - a, b, and c	$16,465	$8,100	$ 8,365
d. Miscellaneous = 10% x Subtotal 16,465	1,647	810	837
Total - a, b, c, and d	18,112	8,910	9,202
GRAND TOTALS	$30,912	$8,910	$22,002

Notes:

(A) Two segment clippers @ $14,500 = $29,000
(B) 2 Semi-skilled @ $1.60 = $3.20

Cost per piece = $\frac{\$30,912}{1,458,000}$ = .0212

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Module Riser Wire Clipping Hand No. HM-2

Equipment Bench, stools, special cutters (A)

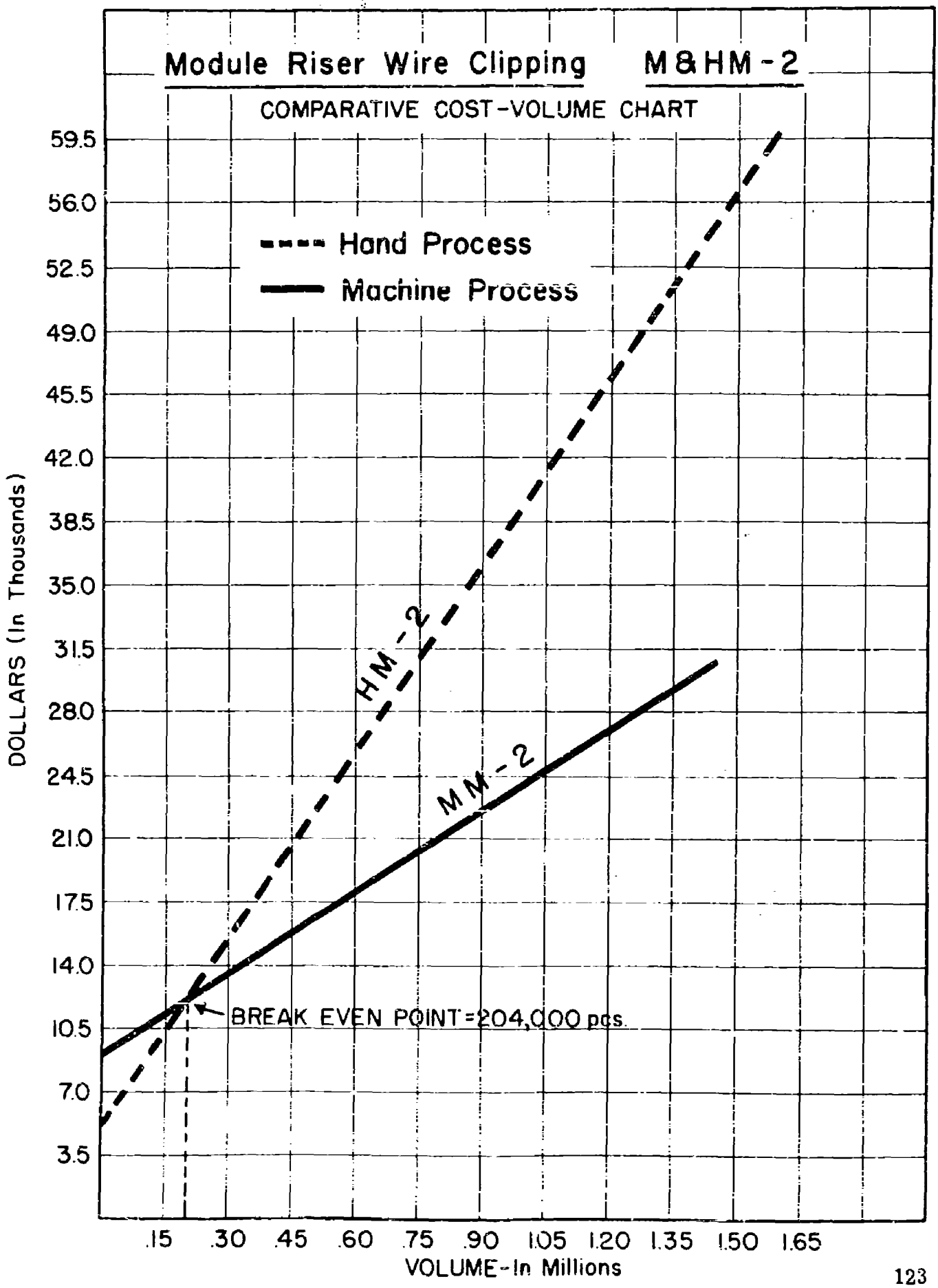
Based on 2 shifts, 4,000 hrs., hourly prod. 400 and annual prod. 1,600,000 (B)

		Annual Cost		
		Total	Fixed	Variable
1. Material			xx	
2. Direct Labor = Hrs. 27,456 (C) x Rate 1.6 =		$43,929.60	xx	$43,929.60
3. Manufacturing Overhead				
a. Ind. Lab. = 30% of Dir. 43,929.60 =		13,178.88	$3,953.66	9,225.22
b. Mach., Equip. & Tool		101.60	82.55	19.05
c. Occupancy = Proc. Space 210 (D) x Ratio 5 = 1,050 sq. ft				
Rent	1050 x .8 =	840.00	840.00	------
Light	1050 x .3 =	315.00	31.50	283.50
Heat	1050 x .1 =	105.00	78.75	26.25
Subtotal - a, b, and c		$14,540.48		
d. Miscellaneous = 10% x Subtotal 14,540.48 =		1,454.05		1,454.05
Total - a, b, c, and d		15,994.53		
GRAND TOTALS		$59,924.13	$4,986.46	$54,937.67

Notes:

(A) Equipment for 7 stations = $894
(B) 10 opers x 40 = 400 x 4,000 = 1,600,000
(C) 6.864 x 4,000 = 27,456 Dir. Lab. Hrs.
(D) 7 stations x 30 sq. ft. = 310 sq. ft.

Cost per piece = $\frac{\$59,924.13}{1,600,000} = .0375$


Module Riser Wire Clipping M&HM-2
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HM-2
MM-2
BREAK EVEN POINT=204,000 pcs.
DOLLARS (In Thousands)
59.5
56.0
52.5
49.0
45.5
42.0
38.5
35.0
31.5
28.0
24.5
21.0
17.5
14.0
10.5
7.0
3.5
.15
.30
.45
.60
.75
.90
1.05
1.20
1.35
1.50
1.65
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Module Testing Mach. No. MM-3

Equipment 2 Module Testers (A)

Based on 2 shifts, 4000 hrs., hourly prod. 654 and annual prod. 1,458,000

Item		Annual Costs Total	Fixed	Variable
1. Material			xx	
2. Direct Labor ▪ Hrs. 2840 x Rate 3.20 (B) ▪		$9,088	xx	$9,088
3. Manufacturing Overhead				
a. Ind. Lab. ▪ 30% of Dir. 9,088 ▪		2,726.40	$ 817.92	1,908.48
b. Mach., Equip. & Tool		6,413.00	3,388.00	3,025.00
c. Occupancy ▪ Proc. Space 20 x Ratio 6 = 120 sq. ft.				
Rent	120 x 1.00 =	120.00	120.00	
Light	120 x .30 =	36.00	4.00	32.00
Heat	120 x .10 =	12.00	9.00	3.00
Subtotal - a, b, and c		9,307.40		
d. Miscellaneous = 10% x Subtotal 9,307.40		930.74		930.74
Total - a, b, c, and d		10,238.14		
GRAND TOTALS		$19,326.14	$4,338.92	$14,987.22

Notes:

(A) 2 Module Testers @ 8,000 ▪ $16,000
(B) 2 Semi-skilled @ $1.60 = $3.20

Cost per piece ▪ $\frac{\$19,326.14}{1,458,000}$ = .01325

PROJECT TINKERTOY -- Manufacturing Cost Data

Process Module Testing Hand No. HM-3

Equipment Bench, Stools & Module Testers (A)

Based on 2 shifts, 4000 hrs., hourly prod. 400 and annual prod. 1,600,000 (B)

	Annual Costs		
	Total	Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 4,400(C) x Rate 1.6 =	$ 7,040.00	xx	$ 7,040.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 7,040.00 =	2,112.00	$ 633.60	1,478.40
b. Mach., Equip. & Tool	4,633.75	3,244.62	1,390.13
c. Occupancy = Proc. Space 60(D) x Ratio 5 = 300 sq.ft.			
Rent 300 x .80 =	240.00	240.00	
Light 300 x .30 =	90.00	9.00	81.00
Heat 300 x .10 =	30.00	22.50	7.50
Subtotal - a, b, and c	7,105.75		
d. Miscellaneous = 10% x Subtotal 7,105.75	710.58		710.58
Total - a, b, c, and d	7,816.33		
GRAND TOTALS	$14,856.33	$4,148.72	$10,707.61

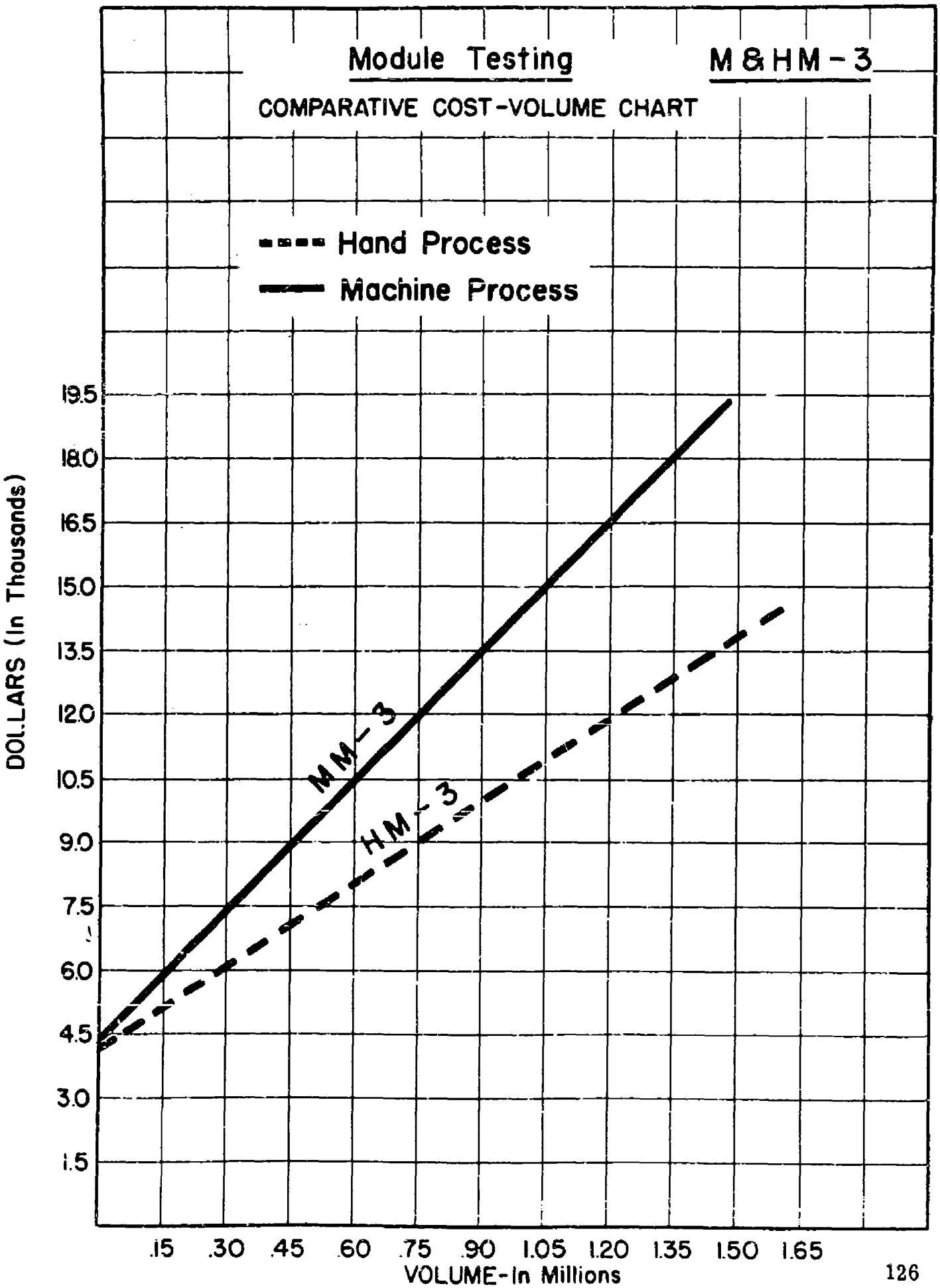
Notes: (A) Equipment for 2 stations = $18,535

(B) 10 operations/mod. x 40 mod./hr. = 400 hrly. x 4000 hrs./yr. = 1,600,000 annual production

(C) 1.10 x 4000 = 4400 Direct Labor Hrs.

(D) 2 stations x 30 = 60 sq. ft.

Cost per piece = $\frac{\$14,856.28}{1,600,000 \text{ pcs.}} = .00928$


Module Testing
M & HM - 3
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
MM-3
HM-3
DOLLARS (In Thousands)
19.5
18.0
16.5
15.0
13.5
12.0
10.5
9.0
7.5
6.0
4.5
3.0
1.5
.15
.30
.45
.60
.75
.90
1.05
1.20
1.35
1.50
1.65
VOLUME-In Millions

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Machine process manufacturing of IF Amplifier Modules

Equipment * See schedule sheets for machine process steps

Based on 2 shifts, 4,000 hrs., and annual production 1,620,000

	Total	Fixed	Variable
** Standard Machine Processing Costs	$785,771	$209,021	$576,750
Special Hand Operations on Modules #1 and #9	19,563	1,843	17,720
GRAND TOTALS	$805,334	$210,864	$594,470

* For cost of equipment see Exhibit 7.

** Total machine processing costs for 1,620,000 modules annually for IF Amplifiers as shown on pertinent schedule sheets in Appendix B.

PROJECT TINKERTOY -- Manufacturing Cost Data

Processes Hand process manufacturing of IF Amplifier Modules

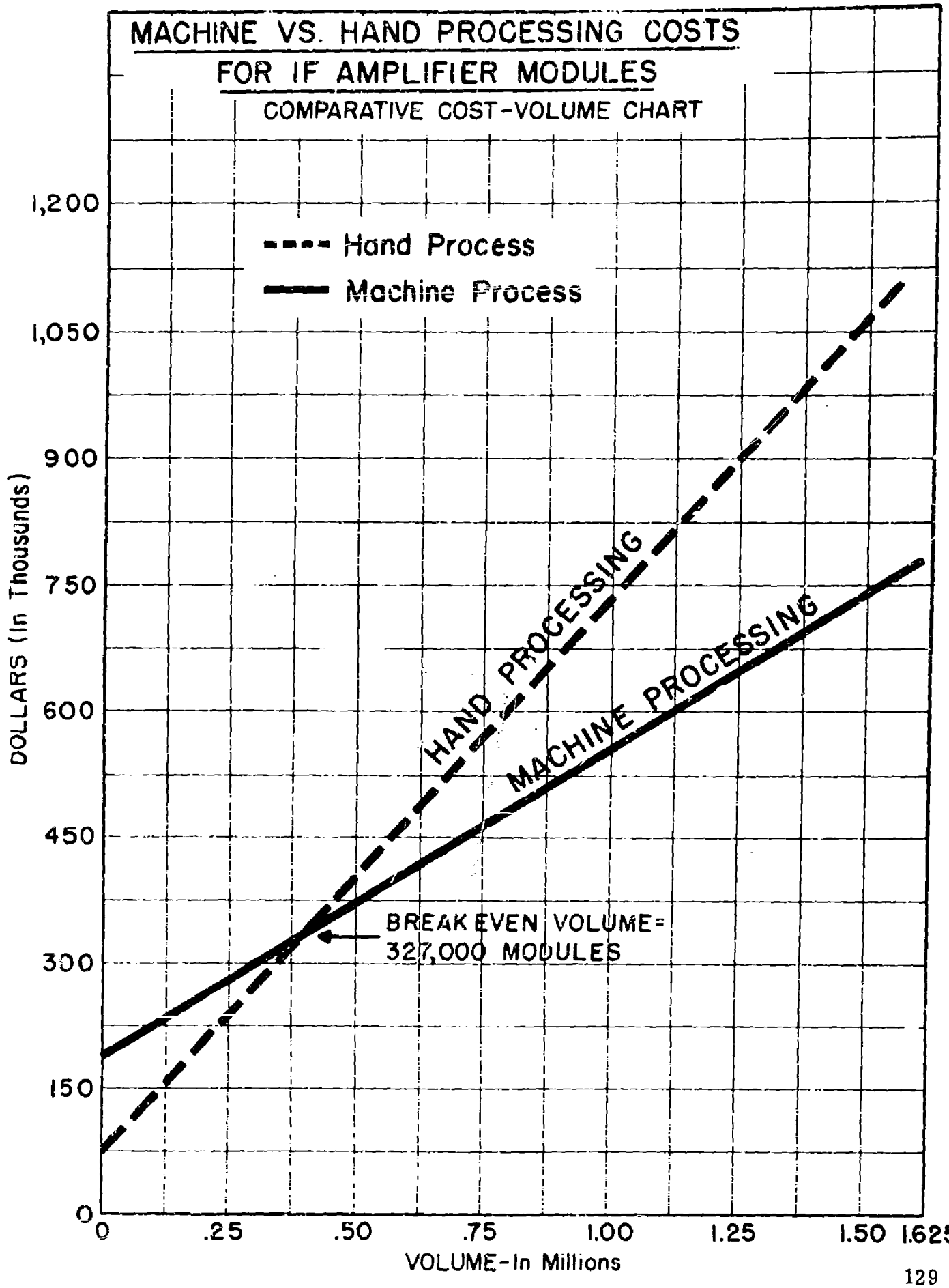
Equipment * See schedule sheets for pertinent hand process steps

Based on 2 shifts, 4,000 hrs., and annual production 1,600,000

	Total	Fixed	Variable
** Standard Hand Processing Costs	$1,172,959	$107,652	$1,065,307
Special Hand Operations on Modules #1 and #9	19,563	1,843	17,720
GRAND TOTALS	$1,192,522	$109,495	$1,083,027

* For cost of equipment see Exhibit 8.

** Total hand processing costs for 1,600,000 modules annually for IF Amplifiers as shown on pertinent schedule sheets in Appendix B1.


MACHINE VS. HAND PROCESSING COSTS
FOR IF AMPLIFIER MODULES
COMPARATIVE COST-VOLUME CHART
Hand Process
Machine Process
HAND PROCESSING
MACHINE PROCESSING
BREAK EVEN VOLUME=
327,000 MODULES
DOLLARS (In Thousands)
1,200
1,050
900
750
600
450
300
150
0
0
.25
.50
.75
1.00
1.25
1.50
1.625
VOLUME-In Millions

APPENDIX C

IF Amplifier Module Cost Data

Schedule	Description
C-1	IF Amplifier Machine Process Module Cost Data
C-2	IF Amplifier Hand Process Module Cost Data

PROJECT TINKERTOY - MACHINE PROCESS IN AMPLIFIER MODULE COSTS

Operation Designation	Operation Description	Unit Labor	Unit Overhead	Module 1 No. Ops.	Module 1 Labor	Module 1 Overhead	Module 2 No. Ops.	Module 2 Labor	Module 2 Overhead	Module 3 No. Ops.	Module 3 Labor	Module 3 Overhead	Module 4 No. Ops.	Module 4 Labor	Module 4 Overhead	Module 5 No. Ops.	Module 5 Labor	Module 5 Overhead	Module 6 No. Ops.	Module 6 Labor	Module 6 Overhead	Module 7 No. Ops.	Module 7 Labor	Module 7 Overhead	Module No. Ops.	Module Labor
MW-1	Wafer Notch Painting	.322/o	.275/o	4	1.288	1.10	5	1.610	1.375	5	1.610	1.375	5	1.610	1.375	5	1.610	1.375	5	1.610	1.375	5	1.610	1.375	5	1.610
MW-2	Wafer Notch Paint Firing	-	.066	4	-	.264	5	-	.330	5	-	.330	5	-	.330	5	-	.330	5	-	.330	5	-	.330	5	-
MW-3	Wafer Pattern Printing	.252	.258	4	1.008	1.032	5	1.260	1.290	5	1.260	1.290	5	1.260	1.290	5	1.260	1.290	4	1.008	1.032	5	1.260	1.290	5	1.260
MW-4	Wafer Pattern Firing	-	.062	4	-	.248	5	-	.310	5	-	.310	5	-	.310	5	-	.310	4	-	.248	5	-	.310	5	-
MW-5	Wafer Pattern Testing	.126	.144	4	.504	.576	5	.630	.720	5	.630	.720	5	.630	.720	5	.630	.720	4	.504	.576	5	.630	.720	5	.630
MC-1	Cap. Wafer Pattern Timming	.37	.214	1	.370	.214	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	2	.740
MC-2	Cap. Body Pattern Printing	.247	.264	3	.741	.792	3	.741	.792	3	.741	.792	5	1.235	1.320	4	.988	1.056	3	.741	.792	3	.741	.792	5	1.235
MC-3	Cap. Body Pattern Firing	-	.101	3	-	.303	3	-	.303	3	-	.303	5	-	.505	4	-	.404	3	-	.303	3	-	.303	5	-
MC-4	Cap. Body Pattern Testing	.172	.108	3	.516	.324	3	.516	.324	3	.516	.324	5	.860	.540	4	.688	.432	3	.516	.324	3	.516	.324	5	.860
MC-5	Cap. Body Pattern Timming	.479	.438	3	1.437	1.314	3	1.437	1.314	3	1.437	1.314	5	2.395	2.190	4	1.916	1.752	3	1.437	1.314	3	1.437	1.314	5	2.395
MC-6	Cap. Body to Wafer Assembly	1.394	1.876	1	1.394	1.876	3	2.788	3.752	3	2.788	3.752	2	2.788	3.752	2	2.788	3.752	2	2.788	3.752	2	2.788	3.752	2	2.788
MC-7	Cap. Assembly Notch Solder Filling	.345	.325	1	.349	.325	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	2	.698
MC-8	Cap. Inspection	.60	.61	1	.60	.61	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20
MR-1	Resistor Tape Application	.191	.286	2	.382	.572	1	.191	.286	1	.191	.286	1	.191	.286	2	.382	.572	1	.191	.286	1	.191	.286	2	3.82
MR-2	Res. Protective Tape Application	.191	.286	2	.382	.572	1	.191	.286	1	.191	.286	1	.191	.286	2	.382	.572	1	.191	.286	1	.191	.286	2	3.82
MR-3	Res. & Protective Tape Curing	-	.14	2	-	.28	1	-	.14	1	-	.14	1	-	.14	2	-	.28	1	-	.14	1	-	.14	2	-
MR-4	Res. Wafer Notch Solder Filling	.367	.347	2	.734	.694	1	.367	.347	1	.367	.347	1	.367	.347	2	.734	.694	1	.367	.347	1	.367	.347	2	.734
MR-5	Res. Inspection	.61	.63	2	1.22	1.26	1	.61	.63	1	.61	.63	1	.61	.63	2	1.22	1.26	1	.61	.63	1	.61	.63	2	1.22
MCS-1	T. S. Wafer Pattern Timming	.37	.214	-	-	-	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37
MTS-2	T. S. Parts to Wafer Assembly	1.84	3.62	-	-	-	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84
MTS-3	T. S. Notch Solder Filling	.331	.299	-	-	-	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331
	Miscellaneous Pattern Timing	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	-	-	-	-	-	-	1	.37	.214	-	-
MM-1	Module Assembly	4.38	6.58	-	-	-	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38
MM-2	Module Riser Wire Clipping	.88	1.24	-	-	-	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88
MM-3	Module Testing	.94	.80	-	-	-	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94
___	Special Hand Operations	-	-		3.52	1.36		-	-		-	-		-	-		-	-		-	-		-	-		-
	Subtotals				14.815/o	13.920/o 14.815/o		22.09/o	27.464/o 22.09/o		22.09/o	27.464/o 22.09/o		23.886/o	29.256/o 23.886/o		23.977/o	29.850/o 21.977/o		21.342/o	26.786/o 21.342/o		22.09/o	27.464/o 22.09/o		88.313/o
	TOTAL LABOR & O. H. (Per Module)					.28735 each			.49554 each			.49554 each			.53174 each			.53127 each			.48128 each			.49554 each		

PROJECT TINKERTOY - MACHINE PROCESS TF AMPLIFIER MODULE COSTS

Module 1			Module 2			Module 3			Module 4			Module 5			Module 6			Module 7			Module 8			Module 9			Module 10		
No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead	No. Ops.	Labor	Overhead
4	1.288	1.10	5	1.610	1.375	5	1.610	1.375	5	1.610	1.375	5	1.610	1.373	5	1.610	1.375	5	1.610	1.375	5	1.610	1.375	5	1.610	1.305	5	1.610	1.305
4	-	.264	5	-	.330	5	-	.330	5	-	.330	5	-	.333	5	-	.330	5	-	.330	5	-	.330	5	-	.330	5	-	.330
4	1.008	1.032	5	1.260	1.290	5	1.260	1.290	5	1.260	1.290	5	1.260	1.290	4	1.008	1.032	5	1.260	1.290	5	1.260	1.290	5	1.260	1.290	4	1.008	1.032
4	-	.248	5	-	.310	5	-	.310	5	-	.310	5	-	.310	4	-	.248	5	-	.310	5	-	.310	5	-	.310	4	-	.248
4	.504	.576	5	.630	.720	5	.630	.720	5	.630	.720	5	.630	.720	4	.504	.576	5	.630	.720	5	.630	.720	5	.630	.672	4	.504	.576
1	.370	.214	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	2	.740	.428	1	.370	.214	1	.370	.214
3	.741	.792	3	.741	.792	3	.741	.792	5	1.235	1.320	4	.988	1.056	3	.741	.792	3	.741	.792	5	1.235	1.320	2	.494	.528	1	.247	.264
3	-	.303	3	-	.303	3	-	.303	5	-	.505	4	-	.404	3	-	.303	3	-	.303	5	-	.505	2	-	.202	1	-	.101
3	.516	.324	3	.516	.324	3	.516	.324	5	.860	.540	4	.688	.432	3	.516	.324	3	.516	.324	5	.860	.540	2	.344	.216	1	.172	.108
3	1.437	1.314	3	1.437	1.314	3	1.437	1.314	5	2.395	2.190	4	1.916	1.752	3	1.437	1.314	3	1.437	1.314	5	2.395	2.190	2	.958	.876	1	.479	.438
1	1.394	1.876	3	2.788	3.752	3	2.788	3.752	2	2.788	3.752	2	2.788	3.752	2	2.788	3.752	2	2.788	3.752	2	2.788	3.752	1	1.394	1.876	1	1.394	1.876
1	.349	.325	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	2	.698	.650	1	.349	.325	1	.349	.325
1	.60	.61	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	2	1.20	1.22	1	.60	.61	1	.60	.61
2	.382	.572	1	.191	.286	1	.191	.286	1	.191	.286	2	.382	.572	1	.191	.286	1	.191	.286	2	3.82	.572	2	.382	.572	2	.382	.572
2	.382	.572	1	.191	.286	1	.191	.286	1	.191	.286	2	.382	.572	1	.191	.286	1	.191	.286	2	-	.28	2	.382	.572	2	-	.28
2	-	.28	1	-	.14	1	-	.14	1	-	.14	2	-	.28	1	-	.14	1	-	.14	2	.734	.694	2	.734	.694	2	.734	.694
2	.734	.694	1	.367	.347	1	.367	.347	1	.367	.347	2	.734	.694	1	.367	.347	1	.367	.347	2	.734	.694	2	.734	.694	2	.734	.694
2	1.22	1.26	1	.61	.63	1	.61	.63	1	.61	.63	2	1.22	1.26	1	.61	.63	1	.61	.63	2	1.22	1.26	2	1.22	1.26	2	1.22	1.26
-	-	-	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214
-	-	-	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.62	1	1.84	3.68	1	1.84	3.62	1	1.84	3.62
-	-	-	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299	1	.331	.299
1	.37	.214	1	.37	.214	1	.37	.214	1	.37	.214	-	-	-	-	-	-	1	.37	.214	-	-	-	1	.37	.214	-	-	-
-	-	-	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.58	1	4.38	6.56	1	4.38	6.58
-	-	-	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24	1	.88	1.24
-	-	-	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80	1	.94	.80
	3.52	1.36		-	-		-	-		-	-		-	-		-	-		-	-		-	-		5.28	2.04		-	-
	14.815/o	13.920/o 14.815/o .28735 each		22.09/o	27.464/o 22.09/o .49554 each		22.09/o	27.464/o 22.09/o .49554 each		23.886/o	29.286/o 23.886/o .53172 each		23.977/o	29.850/o 23.977/o .53827 each		21.342/o	26.786/o 21.342/o .48128 each		22.09/o	27.464/o 22.09/o .49554 each		88.313/o	30.701/o 28.313/o .59074 each		25.118/o	27.139/o 25.118/o .52257 each		18.193/o	23.538/o 18.193/o .41730 each

2/

PROJECT TINKERTOY - HAND PROCESS IF AMPLIFIER MODULE COSTS

Operation Number		No. Ops. Per IF Strip Total	Ea. Pc. Tot. Cost $ D.L. & O.H.	Direct Labor $	O.H. $	M-1 No. Ops.	M-1 D.L.	M-1 O.H.	M-2 No. Ops.	M-2 D.L.	M-2 O.H.	M-3 No. Ops.	M-3 D.L.	M-3 O.H.	M-4 No. Ops.	M-4 D.L.	M-4 O.H.	M-5 No. Ops.	M-5 D.L.	M-5 O.H.	M-6 No. Ops.	M-6 D.L.	M-6 O.H.	M-7 No. Ops.	M-7 D.L.	M-7 O.H.
HW-1	Wafer Notch Painting	49	.01y0	.014	.005	1	.05600	.02000	5	.07000	.02500	5	.07000	.02500	5	.07000	.02500	5	.07000	.02500	5	.9700	.02500	5	.07000	.02500
HW-2	Wafer Notch Paint Fixing	49	.00094	.0007	.00024	1	.00240	.00096	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120
HW-3	Wafer Pattern Printing (1 side)	15	.0022	.0013	.0007	2	.00300	.0014	1	.00150	.00070	1	.00150	.00070	1	.00150	.00070	2	.0030	.00140	1	.00150	.00070	2	.00300	.00140
HW-3	Wafer Pattern Printing (2 sides)	30	.004	.003	.0010	1	.0030	.00120	4	.01200	.00480	4	.01200	.00480	4	.012000	.00480	4	.009	.00360	3	.00936	.00300	3	.00900	.00300
HW-5	Wafer Pattern Fixing	49	.0013	.0007	.0006	4	.00280	.00240	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300
HC-1	Cap. Wafer Pattern Timming	18	.014	.010	.0040	1	.01000	.00400	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800
HC-2	Cap. Body Pattern Timming	36	.0046	.0031	.0015	3	.0[illegible]	.00450	3	.00930	.00450	3	.00930	.00450	5	.01550	.00750	4	.01240	.00600	3	.00910	.00450	3	.00910	.00450
HC-2a	Make Capacitor Leads	36	.00121	.00088	.00033	3	.00264	.00099	3	.00264	.00099	3	.00264	.00099	5	.00440	.00165	4	.00352	.00132	3	.00264	.00099	3	.00264	.00099
HC-3	Cap. Body Pattern Firing	33	.0014	.0007	.0007	3	.00210	.00210	3	.00210	.00210	2	.00140	.00140	5	.00350	.00350	4	.00280	.00280	3	.00210	.00210	3	.00210	.00210
HC-3	Cap. Body Pattern Firing	33	.00[illegible]	.00[illegible]	.0011	3	.00840	.00330	3	.00840	.00330	3	.00840	.00330	5	.01400	.00550	4	.01120	.00440	3	.00840	.00330	3	.00840	.00330
HC-4	Cap. Body Pattern Testing	36	.00[illegible]	.00[illegible]	.00232	3	.01902	.00696	3	.01902	.00696	3	.01902	.00696	5	.03170	.01160	4	.02536	.00928	3	.01902	.00696	3	.01902	.00696
HC-5	Cap. Body Pattern Timming	36	.008[illegible]	.00634	.00232	3	.01902	.00696	3	.01902	.00696	3	.01902	.00696	5	.03170	.01160	4	.02536	.00928	3	.01902	.00696	3	.01902	.00696
HC-5	Cap. Body Pattern Timming	1	.0287	.0211	.0076	1	.02110	.00760	-	-	-	-	-	-	1	.02110	.00760	1	.02110	.00760	-	-	-	-	-	-
HC-6	Cap. Body to Wafer Assembly (.00-.01)	4	.0156	.0114	.0042	-	-	-	1	.01140	.00420	2	.02280	.00840	1	.01140	.00420	-	-	-	1	.01140	.00420	1	.01140	.00420
HC-6	Cap. Body to Wafer Assembly (2-.01)	8	.0156	.0114	.0042	-	-	-	1	.00760	.00210	1	.00760	.00210	-	-	-	1	.00760	.00210	1	.00760	.00210	1	.00760	.00210
HC-6	Cap. Body to Wafer Assembly (1-.01)	7	.0097	.0076	.0021	-	-	-	1	.01250	.00450	1	.01250	.00450	1	.01250	.00450	2	.02500	.00900	1	.01250	.00450	1	.01250	.00450
HC-6a	Assemble Capacitor Leads (1 side)	10	.017	.0125	.0045	1	.01250	.00450	1	.01250	.00450	1	.01250	.00450	1	.01250	.00450	2	.02500	.00900	1	.01250	.00450	1	.01250	.00450
HC-6a	Assemble Capacitor Leads (2 sides)	12	.0307	.0225	.0082	1	.02250	.00820	1	.02250	.00820	1	.02250	.00820	2	.04500	.00164	1	.02250	.00164	1	.04500	.00162	1	.04500	.00820
HC-6b	Cap. Bodies Subassembly	5	.02130	.0155	.00572	1	.01558	.00572	-	-	-	-	-	-	1	.01558	.00572	1	.01558	.00572	-	-	-	-	-	-
HC-6c	Apply Protective Coating (1 side)	8	.0185	.0136	.0049	-	-	-	1	.01360	.00490	1	.01360	.00490	-	.01360	.0049	1	.01360	.00490	1	.01360	.00490	1	.01360	.00490
HC-6c	Apply Protective Coating (2 sides)	10	.0370	.0271	.0099	1	.02710	.0090	1	.02710	.00990	1	.02710	.00990	2	.05420	.01980	1	.02710	.00990	1	.02710	.00990	1	.02710	.00990
HC-6c	Apply Protective Coating (2 sides)	18	.0252	.0141	.0051	1	.01410	.00510	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020
HC-7	Cap. Wafer Notch Solder Filling	18	.0252	.0141	.0051	1	.01410	.00510	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020
HC-8	Cap. Inspection	36	.0064	.0046	.0018	3	.01380	.00540	3	.01380	.00540	3	.01380	.00540	5	.02300	.00900	4	.01840	.00720	3	.01380	.00540	3	.01380	.00540
HR-1	Resistor Tape Application (2 strips - 1 side)	11	.0094	.0069	.0025	1	.00690	.00250	1½	.01035	.00370	1½	.01035	.00370	-	-	-	1	.00690	.00250	1½	.01035	.00370	1½	.01035	.00370
HR-1	Resistor Tape Application (2 strips - 2 sides)	5	.0135	.0099	.0036	-	-	-	-	-	-	-	-	-	2	.01380	.00720	1	.00990	.00360	-	-	-	-	-	-
HR-1b	Resistor Inspection	15	.0121	.0088	.0033	2	.01760	.0066	1	.00880	.00330	1	.00880	.00330	1	.00880	.00330	2	.01760	.00660	1	.00880	.00330	1	.00880	.00330
HR-2	Resistor Protective Tape Application (1 side)	7	.00117	.0078	.0039	2	.01560	.00780	-	-	-	-	-	-	-	-	-	1	.00780	.00390	-	-	-	-	-	-
HR-2	Resistor Protective Tape Application (2 sides)	8	.0170	.0126	.5044	-	-	-	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	1	.01265	.00440	1	.01260	.00440
HR-3	Resistor & Prot. Tape Curing	16	.0014	.0007	.0007	2	.00140	.00140	2	.00140	.00140	1	.00070	.00070	1	.00070	.00070	2	.00140	.00140	1	.00070	.00070	1	.00070	.00070
HR-4	Resistor Wafer Notch Solder Filling	15	.0174	.0127	.0047	2	.02540	.00940	1	.01270	.00470	1	.01270	.00470	1	.01270	.00470	2	.02540	.00940	1	.01270	.00470	1	.01270	.00470
HR-5	Resistor Inspection	15	.0121	.0088	.0033	2	.01760	.00660	1	.00880	.00330	1	.00880	.00330	1	.00880	.00330	2	.01760	.00660	1	.00880	.00330	1	.00880	.00330
TTS-1	Tube Socket Wafer Pattern Timming	9	.01290	.0094	.0035	-	-	-	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350
TTS-2	TS Parts to Wafer Assembly	9	.0280	.0204	.0076	-	-	-	1	.0204	.00760	1	.0204	.00760	1	.0204	.00760	1	.0204	.00760	1	.0204	.00760	1	.0204	.00760
TTS-3	TS Wafer Notch Solder Filling	9	.0375	.0275	.0100	-	-	-	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000
HM-1	Module Assembly	10	.0958	.0678	.0280	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800
HM-2	Module Miser Wire Clipping	10	.0375	.0275	.0100	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000
HM-3	Module Testing	10	.0107	.0044	.0063	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630
	Special Item	1	.1220	.0880	.0340	1	.03520	.01360	-																	
	Subtotals						.46514	.16823		.09951			.19035			.62458			.59916			.51961			.52111	
								.46514					.01047				.22832			.76746			.21961			.19435
								.63337 each			.10951 each		.20082 each				.85290 each			.92707 each			.73922 each			.71545 each
	TOTAL LABOR & O.H. (Per Module)																									

PROJECT TINKERTOY - HAND PROCESS IC AMPLIFIER MODULE COSTS

Ea. Pc. Tot. Cost & D.L. & O.H.	Mtrnal Labor &	O.H. %	M-1 No. Ops.	M-1 D.L.	M-1 O.H.	M-2 No. Ops.	M-2 D.L.	M-2 O.H.	M-3 No. Ops.	M-3 D.L.	M-3 O.H.	M-4 No. Ops.	M-4 D.L.	M-4 O.H.	M-5 No. Ops.	M-5 D.L.	M-5 O.H.	M-6 No. Ops.	M-6 D.L.	M-6 O.H.	M-7 No. Ops.	M-7 D.L.	M-7 O.H.	M-8 No. Ops.	M-8 D.L.	M-8 O.H.	M-9 No. Ops.	M-9 D.L.	M-9 O.H.	M-10 No. Ops.	M-10 D.L.	M-10 O.H.
.0190	.014	.005	4	.03600	.02000	5	.07000	.02500	5	.07000	.02500	5	.07000	.02500	5	.07000	.02500	5	.0700	.02500	5	.07000	.02500	5	.07000	.02500	5	.07000	.02500	5	.07000	.02500
.00094	.0007	.00024	4	.00240	.00096	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120	5	.00350	.00120
.0022	.0015	.0007	2	.00300	.0014	1	.00150	.00070	1	.00150	.00070	1	.00150	.00070	2	.0030	.00140	1	.00150	.00070	2	.00300	.00140	2	.00300	.00140	1	.00150	.00070	2	.00300	.00140
.004	.003	.0010	1	.00300	.00100	4	.01200	.00400	4	.01200	.00400	3	.009	.00300	4	.00900	.00300	3	.00900	.00300	3	.00900	.00300	3	.00900	.00300	2	.00600	.00200
.0013	.0007	.0006	4	.00260	.0024-0	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300	5	.00350	.00300
.014	.010	.0040	1	.01000	.00400	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	2	.02000	.00800	1	.01000	.00400
.0026	.0021	.0015	3	.0093	.004550	3	.00630	.00450	3	.00930	.00450	5	.01550	.00750	4	.01240	.00600	3	.00930	.00450	3	.01550	.00750	4	.01240	.00600	1	.00310	.00150
.00121	.00081	.00033	3	.00264	.00099	3	.00264	.00099	3	.00264	.00099	4	.00440	.00165	4	.00352	.00132	3	.00264	.00099	3	.00264	.00099	5	.00440	.00165	4	.00352	.00132	1	.00088	.00033
.0014	.0007	.0007	3	.00210	.00210	3	.00210	.00210	2	.00140	.00140	5	.00350	.00350	4	.00280	.00280	3	.00210	.00210	3	.00210	.00210	5	.00350	.00350	4	.00280	.00280	1	.00070	.00070
.0039	.0028	.0011	3	.00840	.00330	3	.00840	.00330	3	.0084 0	.00330	5	.01400	.00550	4	.01120	.00440	3	.00840	.00330	3	.00840	.00330	5	.01400	.00550	4	.01120	.00440	1	.00280	.00110
.00866	.00634	.00232	3	.01902	.00696	3	.01902	.00696	3	.01902	.00696	5	.03170	.01160	4	.02536	.00928	3	.01902	.00696	3	.01902	.00696	5	.03170	.01160	4	.02536	.00928	1	.00634	.00232
.0037	.0211	.0076	1	.02110	.00760	-	-	-	-	-	-	1	.02110	.00760	1	.02110	.00760	-	-	-	-	-	-	1	.02110	.00760	-	-	-	-	-	-
.0156	.0114	.0042	-	-	-	1	.01140	.00420	2	.02280	.00840	1	.01140	.00420	-	-	-	1	.01140	.00420	1	.01140	.00420	-	-	-	2	.02280	.00840	-	-	-
.0097	.0076	.0021	-	-	-	1	.00760	.00210	1	.00760	.00210	-	-	-	1	.00760	.00210	1	.00760	.00210	1	.00760	.00210	1	.00760	.00210	-	-	-	1	.00760	.00210
.017	.0125	.0045	1	.01250	.0045	1	.01250	.00450	1	.01250	.00450	1	.01250	.00450	2	.02500	.00900	1	.01250	.00450	1	.01250	.00450	1	.01250	.00450	-	-	-	1	.01250	.00450
.0107	.0225	.0082	1	.02250	.00820	1	.02250	.00820	2	.04500	.00164	1	.02250	.00164	1	.02250	.00164	1	.04500	.00162	1	.04500	.00820	2	.04500	.00162	2	.04500	.01620	-	-	-
.02130	.0155	.00572	1	.01558	.00572	-	-	-	-	-	-	1	.01558	.00572	1	.01558	.00572	-	-	-	-	-	-	2	.03116	.01144	-	-	-	-	-	-
.0185	.0136	.0049	-	-	-	1	.01360	.00490	1	.01360	.00490	-	.01360	.0049	1	.01360	.00490	1	.01360	.00490	1	.01360	.00490	1	.01360	.00490	1	.01360	.00490	1	.01360	.00490
.0370	.0271	.0099	1	.02710	.0090	1	.02710	.00990	1	.02710	.00990	2	.05420	.01980	1	.02710	.00990	1	.02710	.00990	1	.02710	.00990	1	.02710	.00990	1	.02710	.00990	-	-	-
.0192	.0141	.0051	1	.01410	.00510	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	2	.02820	.01020	1	.01410	.00510
.0064	.0046	.0018	3	.01380	.00540	3	.01380	.00540	3	.01380	.00540	5	.02300	.00900	4	.01840	.00720	3	.01380	.00540	3	.01380	.00540	5	.02300	.00900	4	.01840	.00720	1	.00460	.00180
.0094	.0069	.0025	1	.00690	.00250	1½	.01035	.00370	1½	.01035	.00370	-	-	-	1	.00690	.00250	1½	.01035	.00370	1½	.01035	.00370	2	.01380	.00500	-	-	-	1	.00690	.00250
.0135	.0099	.0036	-	-	-	-	-	-	-	-	-	2	.01980	.00720	1	.00990	.00360	-	-	-	-	-	-	-	-	-	2	.01980	.00720	-	-	-
.0121	.0080	.0033	2	.01760	.0066	1	.00880	.00330	1	.00880	.00330	1	.00880	.00330	2	.01760	.00660	1	.00880	.00330	1	.00880	.00330	2	.01760	.00660	2	.01760	.00660	2	.01760	.00660
.00117	.0078	.0039	2	.01560	.00780	-	-	-	-	-	-	-	-	-	1	.00780	.00390	-	-	-	-	-	-	2	.01560	.00780	-	-	-	2	.01560	.00780
.0170	.0126	.0044	-	-	-	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	1	.01260	.00440	-	-	-	2	.02520	.00880
.0114	.0007	.0007	2	.00140	.00140	2	.00140	.00140	1	.00070	.00070	1	.00070	.00070	2	.00140	.00140	1	.00070	.00070	1	.00070	.00070	2	.00140	.00140	2	.00140	.00140	2	.00140	.00140
.0174	.0127	.0047	2	.02540	.00940	1	.01270	.00470	1	.01270	.00470	1	.01270	.00470	2	.02540	.00940	1	.01270	.00470	1	.01270	.00470	2	.02540	.00940	2	.02540	.00940	2	.02540	.00940
.0121	.0083	.0033	2	.01760	.00660	1	.00880	.00330	1	.00880	.00330	2	.01760	.00660	1	.00880	.00330	1	.00880	.00330	1	.00880	.00330	2	.01760	.00660	2	.01760	.00660	2	.01760	.00660
.01290	.0094	.0035	-	-	-	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350	1	.00940	.00350
.0216	.0204	.0076	-	-	-	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760	1	.02040	.00760
.0375	.0273	.0090	-	-	-	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000
.0258	.0678	.0680	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800	1	.06780	.02800
.0375	.0275	.0100	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000	1	.02750	.01000
.0107	.0044	.0063	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630	1	.00440	.00630
.0500	.0360	.0140	1	.03600	.02800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	.05280	.02800	-	-	-
				.46514	.16823		.50651	.19335		.51031	.19815		.62458	.22831		.59926	.22746		.51901	.19707		.58111	.19435		.63576	.23401		.63468	.24738		.40372	.10665
					.63337 each			.70335 each			.70846 each			.85279 each			.82672 each			.71607 each			.87011 each				.88206 each			.50937 each

2/

APPENDIX D

IF Amplifier Assembly & Test Cost Data

Schedule	Description
D-1	IF Amplifier Assembly & Test Cost Data Sheet
D-2	IF Amplifier Assembly & Test Production Rates

IF AMPLIFIER ASSEMBLY & TEST COST DATA

PROJECT TINKERTOY -- Manufacturing Cost Data

Process IF Amplifier Assembly & Test Hand

Equipment Benches, stools, fixture & testing equipment (A)

Based on 2 shifts, 4000 hrs., hrly. prod. 40 and annual prod. 160,000

	Total	Annual Cost Fixed	Variable
1. Material		xx	
2. Direct Labor = Hrs. 61,600 (B) x Rate 1.6 =	$98,560.00	xx	$ 98,560.00
3. Manufacturing Overhead			
a. Ind. Lab. = 30% of Dir. 98,560.00 =	29,568.00	$ 8,870.00	20,698.00
b. Mach., Equip. & Tool	312.50	218.75	93.75
c. Occupancy = Proc. Space 480 (C) x Ratio 5 = 2,400 sq. ft.			
Rent 2400 x .8 =	1,920.00	1,920.00	---
Light 2400 x .3 =	720.00	72.00	648.00
Heat 2400 x .1 =	240.00	260.00	180.00
Subtotal - a, b, and c	$ 32,760.50		
d. Miscellaneous = 10% x Subtotal 32,760.50 =	3,276.05		3,276.05
Total - a, b, c, and d	36,036.55		
GRAND TOTALS	$134,596.55	$11,140.75	$123,455.80

Notes:

(A) Cost for 16 stations = $1,250

(B) .385 x 40 = 15.4 x 4000 = 61,600 dir. lab. hrs. (see Schedule D-2)

(C) 16 stations x 30 sq. ft. = 480 sq. ft.

Cost per piece = $\frac{\$134,596.55}{160,000} = .84$

IF AMPLIFIER

Final Assembly and Test Production Rates

Op. No.	Operation Description	Estimated Production Rate hrs/pc	pcs/hr
	Bottom Plate Assembly		
FA-1	Insert 10 IF Modules	.02578	39
FA-2	Insert 8 decoupling shields	.00992	101
	Top Plate Assembly		
FA-3	Assemble female connector to top plate with eyelets in eyelet machine; solder.	.01289	78
FA-4	Assemble 9 tube shield clips to top plate with eyelet in eyelet machine and solder each clip.	.04253	24
FA-5	Assemble tuning coil and 8 inner stage shields to top plate and assemble top plate subassembly to bottom plate.	.04253	24
FA-6	Solder 8 inner stage shields to top and bottom plates	.107	9
FA-7	Solder all module riser wires and tuning coil connections in special fixture.	.0258	39
FA-8	Assemble 9 tubes, 9 tube shields, transformer shield and coaxial cable; solder.	.08656	12
	Test		
FA-9	Test: Band pass and gain	.03222	31
	TOTAL	.38523	